JUNE 12, 1961

missiles and rockets

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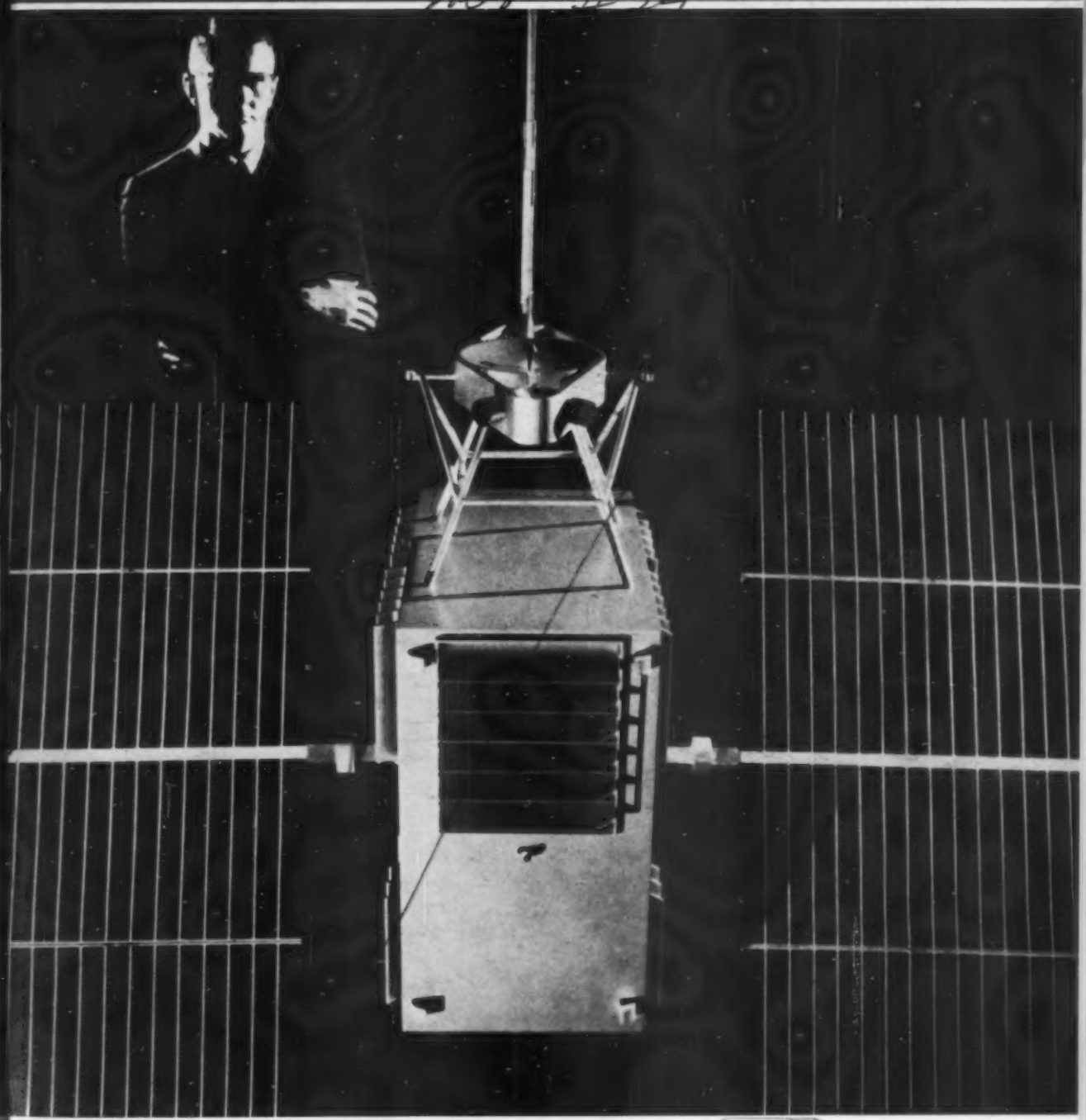
THE MISSILE/SPACE WEEKLY



Model of Army's Advent Communications Satellite

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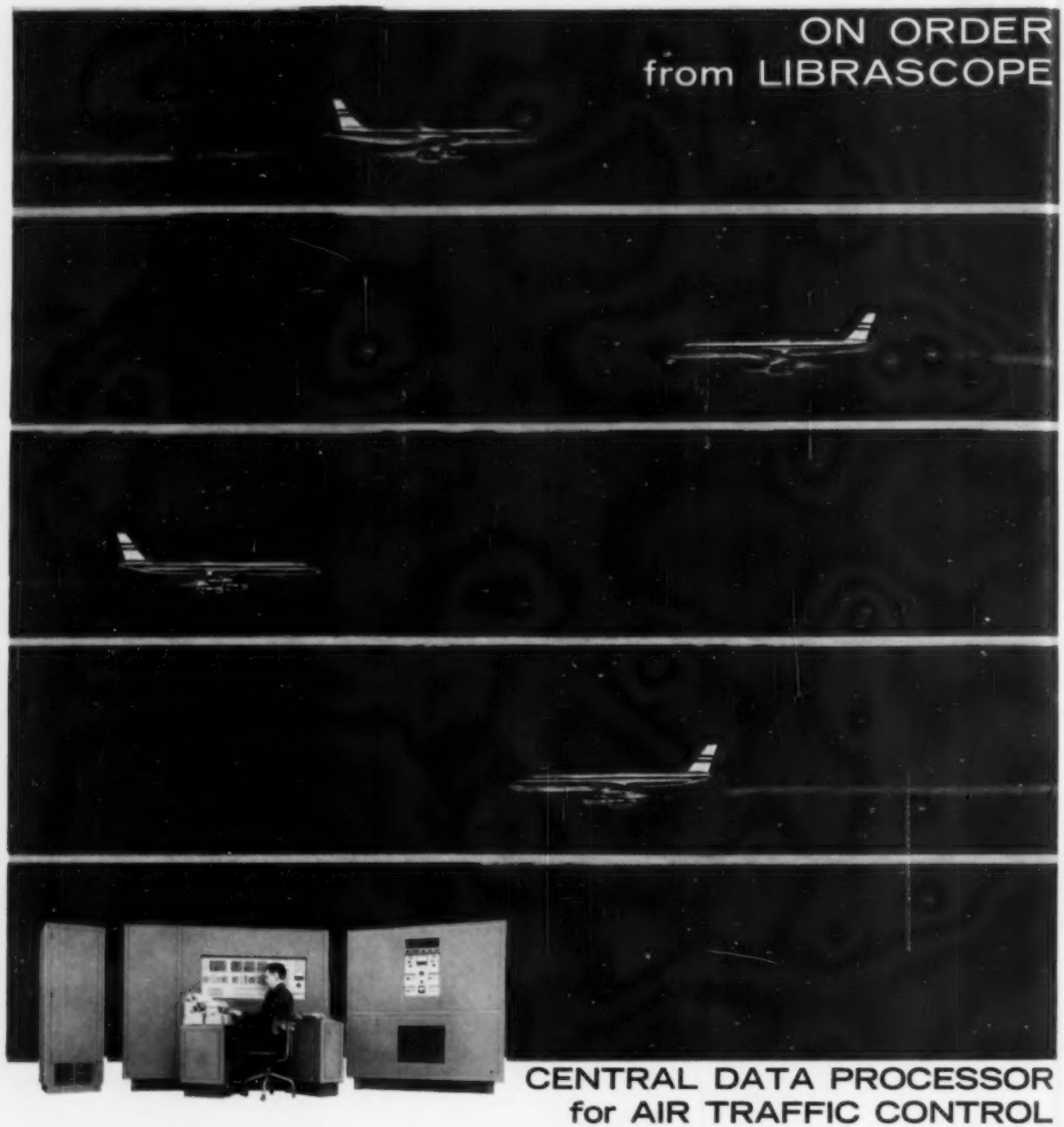

CENTRAL DATA PROCESSOR for AIR TRAFFIC CONTROL

Today, at a peak traffic hour, approximately 200 aircraft flew over the New York area. Each year this number will increase. Yet, the Federal Aviation Agency will continue to assure safe and efficient control of air traffic. One reason . . . a data processor developed for the FAA by Librascope to quickly and accurately handle the routine clerical tasks now occupying most of the controller's time. The first 18-unit data processor will be installed at Boston in 1962. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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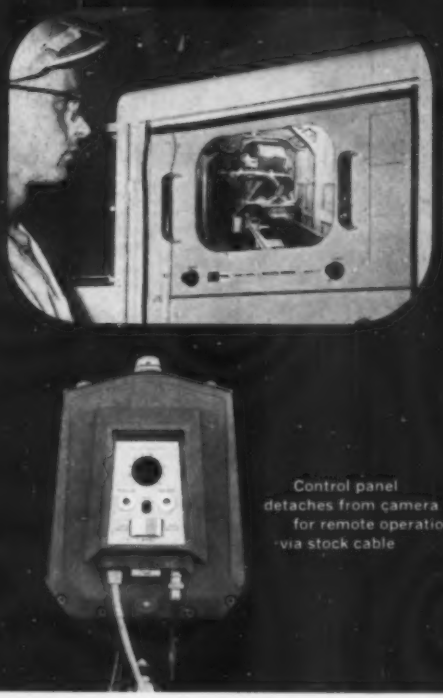
new! low-cost self-contained TV camera provides 650 line resolution!



Control panel detaches from camera for remote operation via stock cable

High-quality closed circuit television is now more practical than ever. KIN TEL's new 20/20 camera is the reason. It contains its own control circuits. This eliminates the separate unit so long traditional with high-quality TV systems... lets you connect the camera directly to a monitor–or home TV receiver.

The 20/20 is easier and less expensive to install, operate, service. Yet it gives the sharpest, clearest pictures in the industry – 650 lines of horizontal resolution. It is so sensitive that you can get usable pictures with as little as one foot candle of illumination–less than the light now falling on this page.

Trouble-free operation is designed into the 20/20. Transistor circuits are used wherever possible. Power consumption is only 25 watts. Protective circuits prevent vidicon damage in case of sweep failure. And the swing-out circuit boards make servicing easy.

Many standard accessories custom-fit the 20/20 to your exact needs. A light compensation circuit automatically adjusts the camera for light variations as great as 4000:1. Motors provide remote control of the lens turret, lens focus, and a lens-speed filter. Sync generators assure 2:1 interlace either in the standard industry-wide sweep/scan pattern, or in the FINELINE pattern that gives you greatly increased vertical resolution. RF modulators make the pictures available on standard TV channels 2 through 6.

Cut costs, reduce errors with one of KIN TEL'S complete lines of high-quality, closed circuit TV. Other companies do. U. S. Steel uses KIN TEL TV to see inside open-hearth furnaces. E. F. Hutton uses one to transmit stock quotations. Los Angeles Department of Water and Power uses KIN TEL TV to check steam plant burners and to view remote water-level meters. The San Francisco Naval Shipyard uses one to guard against pilferage. American Potash & Chemical conveyor lines and warehousing operations are monitored by KIN TEL TV as are radiation studies at General Atomic. The U.S. Air Force uses KIN TEL TV for detailed surveillance of every operational ICBM outside the Iron Curtain. All told, hundreds of KIN TEL TV systems are performing critical and routine jobs safely, inexpensively, tirelessly.

Application help is free for the asking. At no obligation, KIN TEL field engineers will determine whether a TV system can be put to profitable use in your application. Just write direct for catalog 6-203 and the name of your closest KIN TEL representative.

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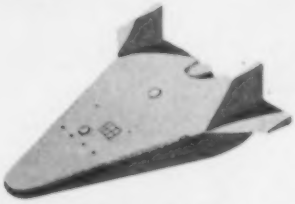
Circle No. 2 on Subscriber Service Card

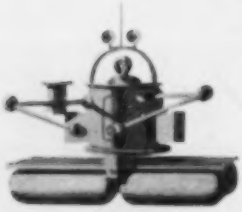
Lunar VTOL Vehicle. A rocket-propelled craft designed to collect lunar ore specimens.

Nuclear Space Ship. An unconventional design by Douglas with living quarters around the ring at the bottom. On landing, it would ease down, ring first.

Nuclear Space Ship. A Douglas design for a space ship with crew quarters and control rooms in the nose, nuclear reactor in the rear.



Supply and Escape Vehicle. A compact re-entry vehicle to supply orbiting space stations or to return crews to earth.



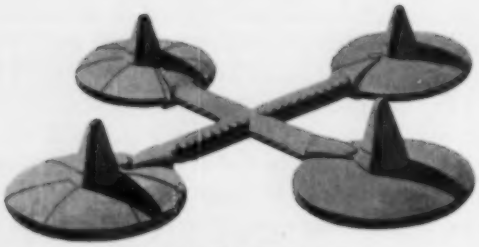
Lunar Service Vehicle. Travels like a "swamp buggy" on inflated rollers. Mechanical arms provided to handle outside chores.

Nuclear Space Ship. A future, medium-thrust, nuclear-electric space ship for one-year interplanetary round trips (Martian and Venusian).

Douglas Thor. Designed as a military IRBM, this dependable missile is the workhorse of the Space Age.

Saturn. First U.S. vehicle designed to put tons of payload into orbit . . . or onto the moon. Douglas-built second stage is as tall as a 4-story building.

Lunar Cargo Handlers. Would load lunar ore samples into containers to be towed back to earth by rockets.



Space Observatory. Sections of this Douglas-designed space station would be sent into space in rockets and be joined together in orbit.

Lunarmobile. Donut-shaped exploration vehicle to use rocket power in space and tractor treads on the moon's surface.

Eleven ways to outwit the law of gravity

When the Space Age dawned, Douglas was ready with specific proposals for space equipment either completed or in advanced stages of development. (Some appear above.)

These Douglas proposals were based on *realistic* estimates of the capabilities of men and materials. They are the valued dividends of the company's considerable experience, gained from the design and production of 30,000 missiles and rockets. These include the Douglas *Thor*, an IRBM which has been totally successful in 86% of its tactical and space firings over the past two years.

Today, Douglas looks ahead to other exciting challenges from its firm position of leadership in the conquest of Space.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 24 June 12, 1961

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THE COVER

Model of Army's Advent communications satellite shown by General Electric, contractor for the vehicle. First flight test of the 24-hour system is due soon. See p. 13.

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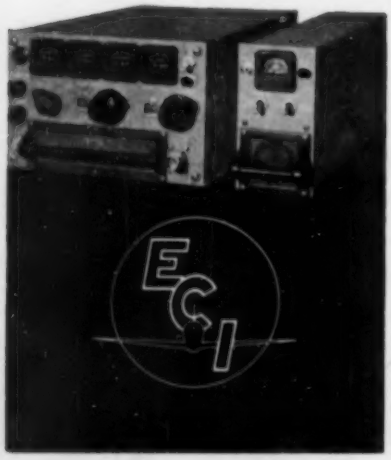

letters

TV as Evidence

To the Editor:

I should like to add a thought to your editorials on the recent *Mercury* firing. It has been argued that our full and open coverage of the firing provided proof that our space claims are honest, in contrast with those of Russia. Do we really know what we are doing when we assert that television coverage constitutes proof? We are furnishing the Russians a standard. If they have fabricated space achievements in the past, they will surely not shrink from filming a moon landing on a movie set and then running it on television as live material. In a closed society, this would be quite simple.

If we argue that television coverage is the seal of legitimacy, we will appear to be poor sports when we challenge Russia's claims to having landed on the moon in a plastic-domed bathtub.

J. N. Gadel
Consulting Physicist
East Orange, N.J.

Standardization Ideal

To the Editor:

You have coined a word that should be struck from the vocabulary.

The implication behind your article "Telemetry Can be Over-Standardized" (M/R, May 29, p. 26) illustrates one of the most misunderstood elements of our technological endeavors—and this misunderstanding, I sincerely believe, is one of the basic causes for many delays in our technological progress—and one that must be corrected if we are ever to "catch up."

I contend that it is impossible to "over-standardize." Actually standardization is merely the act of recording the *current* state of the "art." To over-standardize would, therefore, imply the recording of the future state of the art—which is obviously impossible.

As a former Director of the Military Standardization Program, I am fully aware of why so many scientists and engineers have developed a fear of standardization. I will admit I failed utterly to correct the discrepancies which engendered these fears. This Program was, and still is, a "horse and buggy" operation trying feebly to keep in the race of modern technology which is bounding forward at supersonic speeds. Instead, this Program should be—and most important, could be—one of the most potent forces in the advancement of our sciences. It can never, however, achieve this role as long as it is bound with "red tape" that demands two, three or four years of administrative delays to produce an obsolete standard—and, most unfortunately, just as long to revise one. This "after the fact" procedure can never fulfill the basic requirements of a true standardization program.

Basically what is required is a very dynamic program that would collect, publish and disseminate rapidly the current state of technological knowledge—and one which would rapidly reflect any changes that might occur. A standard would then become what it should be—denoting only something that remains fixed as long as it serves a purpose, and as such is only temporary in nature.

A standardization program based upon these concepts would allay the fears of all, and it would take its proper niche and receive the respect and stature that it rightfully deserves in this era of rapid technological progress.

Can this be done? After a number of years of serious thought and study, I unhesitatingly say yes, the moment someone of authority so wishes. From my experiences, I know it would not be easy—but it could be done.

Incidentally, in respect to this article you might be glad to know that our company will announce very shortly a revolutionary new type of transducer which will eliminate many of the troubles in all areas of telemetry. It will be marketed under the name "Variaducer."

Richard H. Pender
Washington Representative
Mirax Chemical Products Corp.
Washington, D.C.

The Reasons Why

To the Editor:

I want to tell you that I thoroughly enjoyed the editorial in M/R, May 29. I have seen all kinds of reasons why we should go to the moon and, in fact, have several categories of reasons myself that I use in my speeches, but the names that you have for these intrigue me and I want to use them in my speeches from now on.

I am assuming they are original with you and will be giving you the credit not only in my speeches but in any writing I do. If, by any chance, I'm wrong, I am sure you will straighten me out.

Congratulations on a good, colorful idea!

Evan Evans
Executive Director
National Aviation Education Council
Washington, D.C.

Credit for the Panama Theory (that strategic areas in space must be occupied for reasons of national survival) belongs to Dandridge Cole of General Electric (M/R, May 29, p. 86).—Ed.

Suggest Try Isabella

To the Editor:

It is interesting to note your article regarding Columbus's voyage ("New Route to Cathay—Step by Step," by Ralph S. Cooper, M/R, May 29, p. 37). However, additional commentary is warranted to justify the reluctant position taken by the Sovereign State of Genoa. Of primary importance was the lack of decision-making of the Maritime Association for Interna-

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tional Affairs (MAFIA), whose purpose was to devise new means of increasing the treasury reserves. Their delays in policy-making were based on the following factors:

1. There appeared to be no military significance in establishing a new route to Cathay. Thus funding of this ambitious program could not be justified. (All monies had been committed to continuing the cold war with the neighboring state of Padua over establishing the standard length of spaghetti.)

2. The length of the journey was unknown. Academicians suggested delaying the program until the navigational constant—i.e., the distance to the edge of the earth—had been determined. (In observance of the International Geophysical Year, 1492, it was intended to launch a 20-pound bottle tied to a long string to measure this constant. Three previous attempts to launch the bottle had been unsuccessful—one broke on the pier and two others had to be destroyed by rocks immediately after launching, as they floated Eastward rather than Westward.)

3. The question of liquid provisions versus solid provisions for the crew could not be resolved. Solid proponents pointed out that liquid provisions were less storable and took more volume, whereas liquid proponents observed that liquids were more easily digested.

4. The tolerance of the human body to a "waistlessness" state (prolonged starvation) had not been ascertained.

It should be noted that the final committee recommendations on Columbus's voyage were favorable. After due deliberation and weighing all factors, the committee decided to appropriate the necessary funds. Unfortunately, this did not occur until 1512.

Donald D. DeNigris
Massapequa, L.I., N.Y.

Objects to 'Mastery'

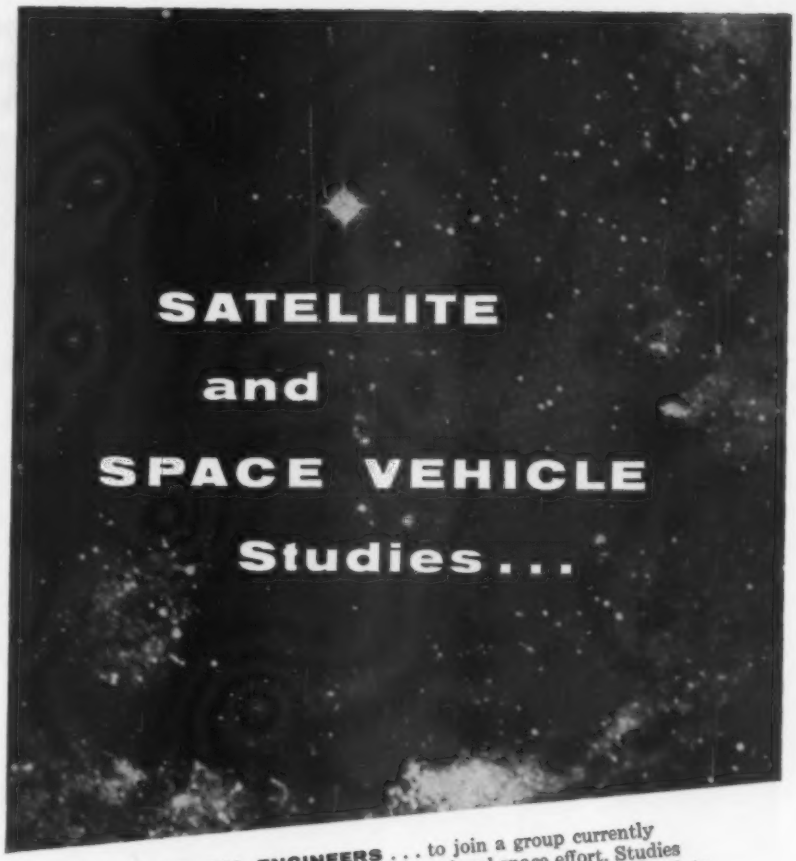
To the Editor:

In "The Missile/Space Week," M/R, May 22, the feature entitled "Grind for Astronauts" impressed me considerably. "Aspiring Astronauts" must indeed be considerably more intelligent than the average "aspiring scientist," in view of the fact that neither myself nor any of my colleagues feel, after some seven or eight years of rather arduous pursuit of such studies as thermodynamics, that we have "mastered" the subject. Apparently these young gentlemen are able to master not only one but no less than a dozen or more in six months.

I do not object in any way to giving credit where credit is due, and no doubt these test pilots must be superb specimens of humanity, not only physically but mentally. However, I feel that it would be more reasonable to state that the subjects mentioned are perhaps "introduced" or "scanned." Most assuredly these people come nowhere near to a mastery of any one of these subjects.

Otherwise, I feel your magazine is quite good, and I thoroughly enjoy reading it.

James W. Buchanan
Graduate Fellow, Chemical Physics
University of Florida, Gainesville



ASTRONAUTICAL ENGINEERS . . . to join a group currently making significant contributions to the national space effort. Studies include determination of economical methods for boosting payloads into orbit; maximizing payloads for inter-planetary missions; determination of satellite arrays for full-time weather observations of the earth's surface.

Requirements include an advanced degree in Aeronautical Engineering, Astronautics or Mechanics with a strong background in Applied Mathematics. A knowledge of celestial mechanics is desirable.

PRELIMINARY DESIGN ENGINEER . . . for a group responsible for analytical studies of advanced vehicle concepts and their propulsion systems. Work will include the selection of structure types and estimation of structure and component weights for space vehicles, missiles, conventional aircraft, and VTOL's.

The position requires a background of experience with broad studies in which structural weights have been developed on a generalized basis. Advanced degree in Aeronautical Engineering preferred, although consideration will be given to a B.S. with extensive applicable experience.

Respect for individuality Our overall organization is small. Office areas are designed to provide an environment for mental concentration. Widely circulated technical reports bear the signature of those responsible for the study; publication of papers is encouraged.

Advancement opportunities are excellent within our organization and in the operating divisions of UAC. Attractive, too, are the salary levels, fringe benefits, relocation allowances, and the fully-paid graduate study program. Work is primarily corporate-sponsored with inherent personal stability. Typical of the facilities available to our staff is a computational laboratory that ranks among the largest in our nation.

Please write Mr. W. E. Walsh, Personnel Department:

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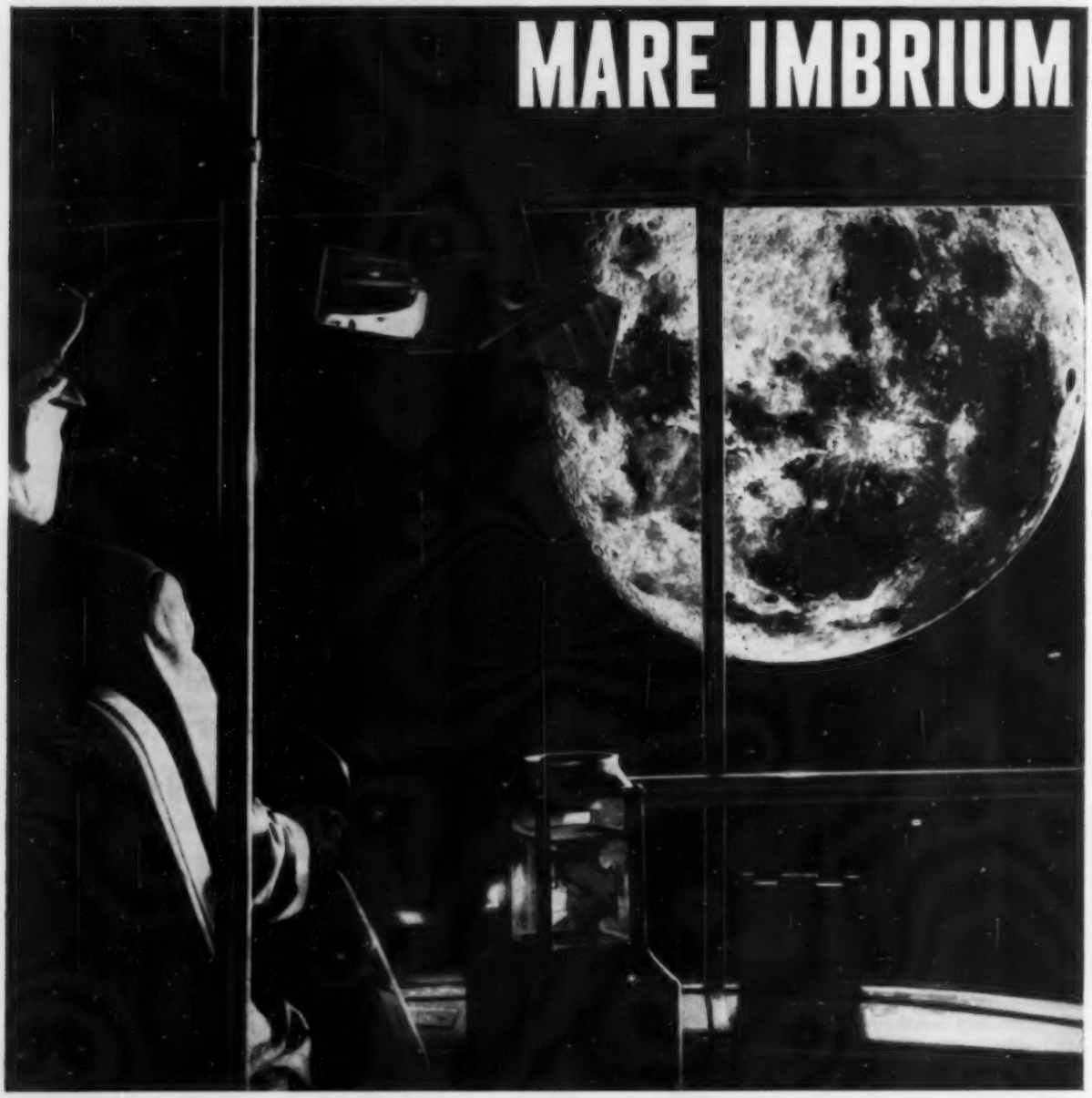

One of the primary needs in the next generation of our space program is for a reliable "space bus" to carry a variety of exploratory packages to the moon and possibly the near planets. Once it is injected into a lunar or planetary trajectory, this bus will guide itself to its destination, accomplish a soft landing, activate and release its payload.

The problems involved in the design of such a vehicle, and of the many kinds of lunar and planetary exploration packages it might be called on to carry, are being intensively explored at Northrop. These investigations cover guidance, communications and position sensing systems, thermal and environmental conditioning, structural and material development, systems integration, trajectory and error analysis, computer design, self-contained, automatic ground support systems, and a host of other essential areas.

If you are interested in taking part in this effort, and have the experience, ability and creative insight to work well in advance of the state of the art, there may well be a place for you at Northrop.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

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The Countdown

WASHINGTON

Sales Push: Boosters for Europe

U.S. big missile makers are engaging in an earnest sales campaign to get European nations to buy large rocket boosters for space work. Martin—for one—is trying to drum up interest in the *Titan II*. Others are following suit. Martin, incidentally, estimates that by 1970 combined gross expenditures by the U.S. and NATO for defense, space and related activities will total about $85 billion a year. Included in this figure is a 50% increase in U.S. military spending.

ICBM Progress in the Tall Corn

Operational *Atlas* ICBM's are understood to be undergoing checkout at the launching sites near Forbes AFB, Kan. Another *Atlas* squadron base nearing completion is at Lincoln AFB, Neb. To date there are about 27 *Atlases* operational at Warren AFB, Wyo.; Offutt AFB, Neb.; and Vandenberg AFB, Calif.

Subroc Production To Start

The Navy is planning to begin pilot production of the Goodyear *Subroc* in FY '62, but the initial deployment date for the nuclear-tipped underwater-to-underwater missile has become somewhat blurred. The submarine-launched *Subroc* was expected to be initially deployed this year. This now appears doubtful.

Apollo HQ Site Sought

NASA is looking over a number of possible sites for its proposed $60-million manned space flight center. Among the possibilities: Moffett AFB, Calif., and McDill AFB, Fla. The new center would become the headquarters for the Space Flight Task Group that now directs the *Mercury* program and will direct *Apollo*. The group now number nearly 800 people; the new FY '62 budget proposes adding 800 more.

A Look Ahead at ASW R&D

The Navy is estimating now that unless it receives a big step-up in RDT&E funding the ASW slice will continue to run between $200 million and $250 million over the next three years. The Navy is requesting $235 million for ASW RDT&E in FY '62. Meantime, the FY '62 budget contains $8.3 million for anti-ASW R&D work in the field of ship noise reduction.

What's-in-a-Name Dept.

The Air Force is being forced to turn its attention from possibly more important things to thinking up a new name for *Saint*—the RCA satellite inspection program. There have been some strong objections to the name from various groups—apparently with enough political push to get the Air Force project-naming people to reconsider *Saint*.

INDUSTRY

Vela Contracting Under Way

DOD's Advanced Research Projects Agency is moving ahead with contracts on the *Vela* program for detecting nuclear explosions underground and at high altitudes. Geomeasurements Division of United Electrodynamics has one award for more than $500,000 to supply seismic instruments to 125 earthquake-reporting stations around the globe. General Electric's TEMPO (at Santa Barbara, Calif.) received a $233,000 contract to develop recommendations for a world-wide system of ground-based instrumentation for detecting nuclear explosions in the upper atmosphere and near-space.

R&D Intelligence

North American's Rocketdyne Division is building a $300,000 solid propellant R&D facility near Reno to test-fire small batches of advanced fuel. . . . Movement by Aerojet-General into the big solid booster field is prompting the company to set up a separate Space Propulsion Division. . . . Recent record-setting *X-15* speed run was preceded by a *Judi I* high-altitude wind information rocket fired by NASA over PMR to a height of 240,000 ft. . . . Latest *Discoverers* are being equipped with radio command guidance instead of autopilot in the *Thor* booster stage.

Bullet Cores for Surplus Food

New twist in DOD procurement contracts: The Army has let what is believed to be the first barter contract in its history. Army Ordnance has purchased about $8 million worth of bullet cores from Firth Sterling of Pittsburgh—with some 30% of the contract payable in surplus agricultural products from the Commodity Credit Corp.

INTERNATIONAL

Belatedly—An RAF 'Space Force'

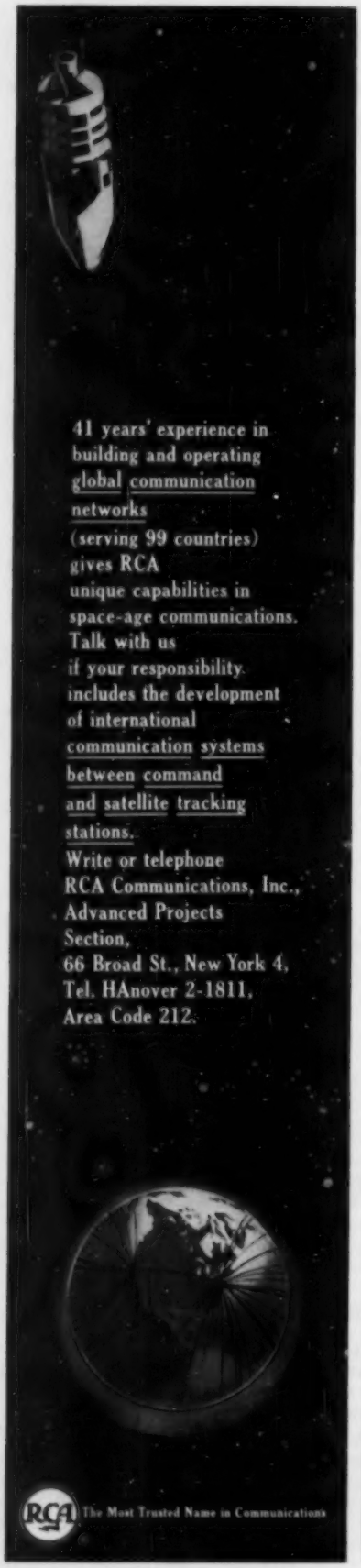
Britain's Royal Air Force has finally decided to set up a special "Space Force" to cope with the threat of space weapons. Systems required may include satellite inspection and destruction by ground-based weapons, and the employment of navigation and communications satellites.

Overseas Pipeline

Hungarian Communist Boss Kadar claims his country needs rocket weapons for defense. . . . De Havilland and Matra are expected to collaborate on an air-to-air missile based on the *Matra 530* for sale to NATO countries. . . . COUNTDOWN hears an attempt to get Project LIL (Lunar International Laboratory) under way will be made at various international astronautic meetings in Washington during October.

Gagarin's Big Booster

U.S. space scientists are now calculating that the booster which put Russia's Yuri Gagarin into orbit April 12 had from 1.3 to 1.8 million lbs. thrust. These are extrapolations from the sketchy details filed by the Russians with F.A.I. (20 million h.p. total thrust, 10,395 lbs. total payload, apogee 203 mi). Takeoff was from "cosmodrome" at Baykonur near Aral Sea and landing near Smelovka in Siberia. F.A.I. will decide July 17 at Paris whether to accept both U.S. and Russian space flight record claims.



The Missile/Space Week

Shots of the Week:

An advanced model *Atlas-E* blew up at launch on June 7 and wrecked a $2.2-million "Hollywood Hard" operational system test facility at Vandenberg AFB.

It was the first attempt at launching the E-series from the semi-hardened launch pad, and the first use of production operational equipment. The test, planned for 4000 miles, was to confirm operational compatibility of all component systems—missile, launch procedures, ground support facilities.

The series E, with 390,000 lbs. thrust, has 30,000 lbs. more than series D. Cause of the explosion was not immediately known.

An *Aerobee-Hi* rocket carrying a weird flower-like trap to capture space dust was launched and recovered at Holloman AFB June 6.

The experiment, supervised by the Air Force Cambridge Research Laboratory, sought to pick up samples of micrometeorites between 40 and 100 miles above the earth. Results are being evaluated.

SAC Bomber Dividend

House-Senate conferees approved a compromise $12.5 billion FY 1962 military procurement authorization bill carrying $525 million more than the President's request for manned long-range SAC bombers.

The bill overrides the House request for only $337 million for B-52H (carrying *Skybolt*) and/or B-58's. Choice of plane is now left to the Department of Defense.

NERVA Team Chosen

An Aerojet General/Westinghouse Electric team has been picked as contractor for the first phase of the *Nerva* nuclear rocket engine.

The two were among seven companies which submitted proposals on the joint NASA-AEC project.

Terms of the R&D contract, set for six months, will include engine design work supporting Los Alamos Scientific Lab *Kiwi-B* reactor tests, and preparation of a developmental plan with costs and work required to meet a feasible flight schedule date.

Nerva is part of Project *Rover*, a joint NASA-AEC nuclear rocket propulsion program. Contract amount was not disclosed.

Other companies which submitted proposals for the program are American Metal Products Corp., General Electric, Pratt & Whitney, Rocketdyne and Thiokol.

Shepard in AOK Shape

A weight loss of three pounds and a slight blurring of vision was the inconsequential payment exacted from Alan Shepard for the *Mercury Redstone* flight.

At a press conference held in Washington, doctors said Shepard is in superb condition and has no permanent effects from the experience.

Shepard described the blurring of vision—which occurred during 15 seconds of the capsule's greatest vibration—as slight. He asserted he still could have seen warning lights had they flashed.

Water-filled Atlas Version

A "swimming pool" 80 ft. deep has been built by Convair to test the *Atlas* launcher mechanism at Vandenberg, AFB, Calif.

Called "Water Bird," the "pool" is an iron shell identical in size and shape with the new Series F *Atlas*. It has a capacity of 28,000 gallons of water. For testing, the Water Bird replica is lowered into the *Atlas* underground silo. Water is then pumped

"WATER BIRD" Atlas poised over silo.

in, providing the same weight distribution as a fully-fueled Series F missile. Included in the checkout are electrical, launch platform drive and balance systems.

Specifically, the tests will determine that silo equipment specifications meet exacting tolerances. Two systems, electrical and launch platform drive, will be put through a series of operations to establish whether they function dependably under prescribed conditions.

In addition to tests, Water Bird will provide realistic training for SAC launch crews before they are assigned to operational bases.

FCC Hard Pressed

The problem of who should own and operate the proposed communications satellite system has yet to be solved by the Federal Communications Commission.

At hearings held last week, the conflict continued over whether only international carriers—as FCC proposes—should be allowed in on the venture. General Electric, as an equipment manufacturer who wishes to participate, led the dissent.

Justice Department representatives urged a wider base of ownership to reduce the possibility of a monopoly and to promote research and development.

The FCC is trying to move ahead by forming an *ad hoc* committee to set up objectives and a plan of action. However, even the question of who in industry will be asked to sit on the committee remains to be resolved.

Soviet Research Chief Dies

The head of the powerful new Soviet supercommittee for research died suddenly last week of a heart attack.

Sixty-year-old deputy premier Mikhail Khrunichev had been named research head several months ago under the recent Russian reorganization (M/R, April 24, p. 34).

The Soviets have not announced a successor to the key post.

York Recalls Duplication

Dr. Herbert York, former DOD R&E chief, has cited the *Thor* and *Jupiter* development programs as instances of "unwarranted duplication."

In Congressional testimony just released, York also said that the *Atlas* and *Titan* programs had some undue complication and occasional duplication. But in the latter case, "it would have required an inhuman degree of foresight" to avoid it, he said.

The testimony was given before the House Mahon Subcommittee in April.

Aerojet Fires Biggest Solid

The largest solid rocket motor ever assembled in the U.S. was successfully fired by Aerojet-General Corp. A half-million pounds of thrust was produced by the 50 tons of solid propellant in the 8 ft. 4 in.-diameter, 30-ft.-long assembly of three segments.

Vibrations from the firing were felt over 60 miles away. The smoke cloud was visible up to 30 miles away.

The motor was made up of three segments joined together just before firing. Aerojet said this would make it easy to produce, transport and assemble at a launch site. Field engineers claimed it could be assembled in less than five minutes.

Dan Kimball, Aerojet president, said that more segments could be added to the motor to increase its power.

INSIDE record solid-rocket motor casing.

The 55-ton rocket motor was third in a series tested under the Air Force solid-rocket motor program at Aerojet's Sacramento plant. Subscale motors of 20 and 25 tons were fired earlier this year. The program is under technical direction of the Directorate of Rocket Propulsion at the AF Flight Test Center, Edwards AFB, Calif.

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After redesigning . . .

Titan Superbooster by 1963

Details of FY '62 R&D by services; hassle over Zeus continues; new timetable is set for booster development

by James Baar

THE PLANNED acceleration of the National Booster Program is expected to produce its first payoff in the form of a *Titan II* superbooster in about 18 months.

The Air Force is understood to be aiming at redesigning the Martin *Titan II* ICBM with new staging that would provide a space booster with possibly as much as 750,000 to 800,000 lbs. of thrust. That would be more than twice the present thrust of the *Atlas* and about equal to the lowest figure usually estimated for the Soviet Union's big boosters.

The extra thrust for *Titan II* is expected to be supplied by a new high-energy liquid-propellant upper stage that probably will take the place of the present second stage.

However, a number of other proposals are being considered. These include such ideas as adding the new stage to the present second stage, the use of off-the-shelf solid-propellant motors for upper stages, and the clustering of solid-propellant motors to the side of the *Titan II* first stage.

• **Breakdown**—Plans for the National Booster Program were learned as Congress released new details of military R&D programs for FY '62:

—Air Force appropriation requests include $74.5 million for *Atlas*, $358 million for *Titan*, $380.5 million for *Minuteman*, $276 million for *Samos*, $201 million for *Midas*, $26 million for *Saint*, $54.9 million for *Discoverer*, and $267 million for advanced systems. The funding for the three ICBM's completes their development. *Samos* funding is about the same as last year, when it reached $273.8 million; *Midas* is almost doubled.

—The Army is requesting $87.1 million for R&D on the 350-mile-range *Pershing* (see below). That will bring to $459.1 million the total R&D cost of *Pershing* through FY '62. Army proposals to develop a 1000-mile-range *Pershing II* are still on a Defense Department shelf.

—The sharp split in Defense Department and Army opinion over the value of *Nike-Zeus* continues. Dr. Herbert York, recently resigned Pentagon R&E Chief, testified: *"Zeus* is highly vulnerable to the use of missile penetration aids (decoys, jamming and so forth.)" The Army denied it.

—The Navy is seeking $17 million for the *Transit* navigation satellite; $443 million for *Polaris;* $7.7 million for the Atlantic Undersea Test and Evaluation Center (AUTEC). The FY '61 appropriation for AUTEC was $5.7 million.

One of the principal reasons being advanced for rapid development of the *Titan II* space booster is the need for additional thrust to place the first *Advent* communications satellites into 22,000-mile orbits in 1963.

Deputy Defense Secretary Roswell Gilpatric told the Senate Space Committee that the *Atlas Centaur*, scheduled for use as the booster for *Advent*, "looks as if it might not be large enough."

He said *Atlas Centaur* would have had sufficient thrust for the 1250-lb. *Advent* planned earlier. But the weight of *Advent* now has been increased (see p. 13). Gilpatric said the planned *Titan II* booster would be able to put one-ton payloads into 22,000-mile orbits.

• **ETA's**—The new timetable for development of new boosters under the National Booster Program is shaping up like this: The *Titan II* space booster—operational in 1963; *Saturn C-1*—operational in late 1963-early 1964; liquid-propellant *Nova* and solid-propellant *Nova*—static firings in 1964; *Rover* nuclear-powered booster—flight tests in 1965-67 and manned flights about 1970-71.

Gilpatric expects a choice between the liquid and solid *Novas* for NASA lunar landing work will be made about late 1964.

He also suggests that by then the Pentagon might have a "military requirement" for a multimillion-lb.-thrust booster. Few top Air Force officials would disagree. ⌗

Trudeau Lashes Back at Pershing Critics

THE MARTIN *PERSHING* system underwent a heavy drubbing in newly-released testimony before the House Defense Appropriations Subcommittee. At the same time, the Army retorted with some hard-hitting statements in defense of the biggest of its second-generation solid-propellant missiles.

The criticism (presented in the form of a memo by unidentified authors):

• *"Pershing* is not sufficiently mobile. To carry the missile, its related computers, radars and so forth, requires four track vehicles. The system is very cumbersome for air transport. . . . The *Pershing* is not air-droppable."

• "The missile is not useful in non-nuclear war. The expense of using such a vehicle to deliver high explosives . . . is probably prohibitive. (Also) maybe the accuracy is not good enough for the use of mere (high) explosives."

• "The *Pershing* system will depend somewhat on drones for reconnaissance. The drone development program has run into difficulty."

The answers (given by Lt. Gen. Arthur Trudeau, Chief of Army R&D):

"This is another one to cut down on efforts that are being productive . . . with nothing positive offered to substitute for it. This is typical of some of the very dangerous thinking I think we have in this country. We have stated the characteristics and the characteristics as stated to number of vehicles it takes to move them is perfectly true. Once this system is on the primary land mass with a track vehicle we are not concerned with the limitation of roads and we have a range which gives us the greatest flexibility."

"I would like to record (that in World War II it took) three days and 200 bombers launched from England to destroy an armored division located east of Paris when . . . in 30 minutes one *Pershing* could have destroyed that division.

"So it is not the answer to all our prayers or anything of the sort. Nevertheless, we think we have here a missile that has been developed and well be in production and delivered to troops . . . that is an outstanding example of missilery."

Further testimony noted that the Army's *SD-5* drone was "somewhat behind schedule" but has "been performing very well" and will be procured with FY '62 funds.

Asked whether there is anything on drawing boards that supersedes the *Pershing*, Trudeau said: "No. Nothing approaches it." ⌗

MODEL of antenna towers being built by Sylvania for ground stations in Advent satellite test program.

Weight Added To Army's Advent

Military communications satellite will now weigh more than 1250 lbs.; system's contractors disclose new design details

NEW DESIGN requirements are forcing an increase in the weight of the Army's *Advent* communications satellite.

Earlier plans had called for a 1250-lb. satellite. The latest weight is now officially described as "somewhat more" than this figure. Nature of the weight increase is classified.

However, some more technical details of the system—scheduled for first test launching on an *Atlas-Agena* this year—became available last week.

The *Advent* program is an R&D project to determine feasibility of a microwave-repeater satellite complex to improve worldwide military communications. Eventually, a minimum of three satellites would be placed in 24-hour equatorial orbits, spaced 120° apart. Ideal orbit will be at an altitude of 22,300 miles as nearly circular as possible.

The more-than-1250-lb. satellite will receive, amplify, and re-transmit radio signals from station to station.

Prime contractor for the nearly $200-million Signal Corps program is Bendix Corporation's System's Division at Ann Arbor, Mich. General Electric will develop the space vehicle and associated power, control, and electronic equipment under direction of the Air Force's Ballistic Systems Division. The Army Signal Research and Development Laboratory at Fort Monmouth, N.J., will provide project management and direct technical support.

Conceived first in the fall of 1958, *Advent* evolved in February, 1960, from three programs contemplated during 1959 (*Steer, Tackle,* and *Decree*).

• **Initial test program**—Early system flight tests will be at relatively low altitudes with a six-hour period. Because of the shorter flight path, the tests of the control system will be much more severe than for a synchronous orbit at the higher altitude.

Initial studies will cover the power equipment (solar cells and nickel-cadmium batteries), altitude and orbital control systems (reaction jets, reaction wheels, horizon scanners, and solar sensors), system temperature control and operating environment, plus the complete ground support system.

Windup of the early tests will be trial operation of the complete system and ancillary equipment.

An *Atlas-Agena* will serve as the booster for the low-altitude orbital trials. *Atlas-Centaur* will boost the satellite into its equatorial 24-hour orbit.

• **24-hour orbit**—In the synchronous phase of the test program, the satellite will hover over the equator in the same longitude as Denver. With the *Centaur* launches, some tests will require a transfer ellipse at the proper equatorial crossing; others will go directly into a 24-hour orbit.

During these tests, control will be maintained at Fort Monmouth. The Air Force will be responsible for launch operations at Cape Canaveral and for orbit control tests at its Sunnyvale Test Center in California.

Ground stations for the program are now under construction by Sylvania Electric Products, Inc., at Camp Roberts, Calif. and Fort Dix, N.J. The project includes design and development of towers and superstructures for aiming the 60-foot paraboloidal reflector antennas used at each station for tracking.

A third station will be provided by the Navy. This shipborne facility will employ a 30-ft. tracking dish now under development by General Electric's Ordnance Dept.

For early tracking, telemetry, and system command tests, a fourth station will be used at Kaena Point, Hawaii.

Three antennas will be employed on the satellite: a receiving horn, a relay dish, and an omnidirectional antenna for tracking, telemetry, and command functions.

The real-time repeater subsystem will provide four r-f channels able to handle 12 voice circuits each and an undisclosed number of data circuits.

Each satellite in an operational system will be in direct line of sight of a segment of the earth's surface some 11,300 miles in diameter.

Solar cell paddles will have one degree of freedom to rotate for continuous alignment with the sun. Once each orbital period, the paddles will be flipped to re-orient them for the next orbit.

Batteries will provide power for the 74 minutes of darkness experienced by the satellite when eclipsed by the earth during each period.

Louvers will be provided on the shadow sides of the craft to maintain passively internal temperature within the range of 50-75°F. ⌗

Hitchhiking on Scout . . .

S-55 to Explore Threat of Punctures

NASA satellite is designed to find out whether manned vehicles face real hazards from tiny micrometeoroids

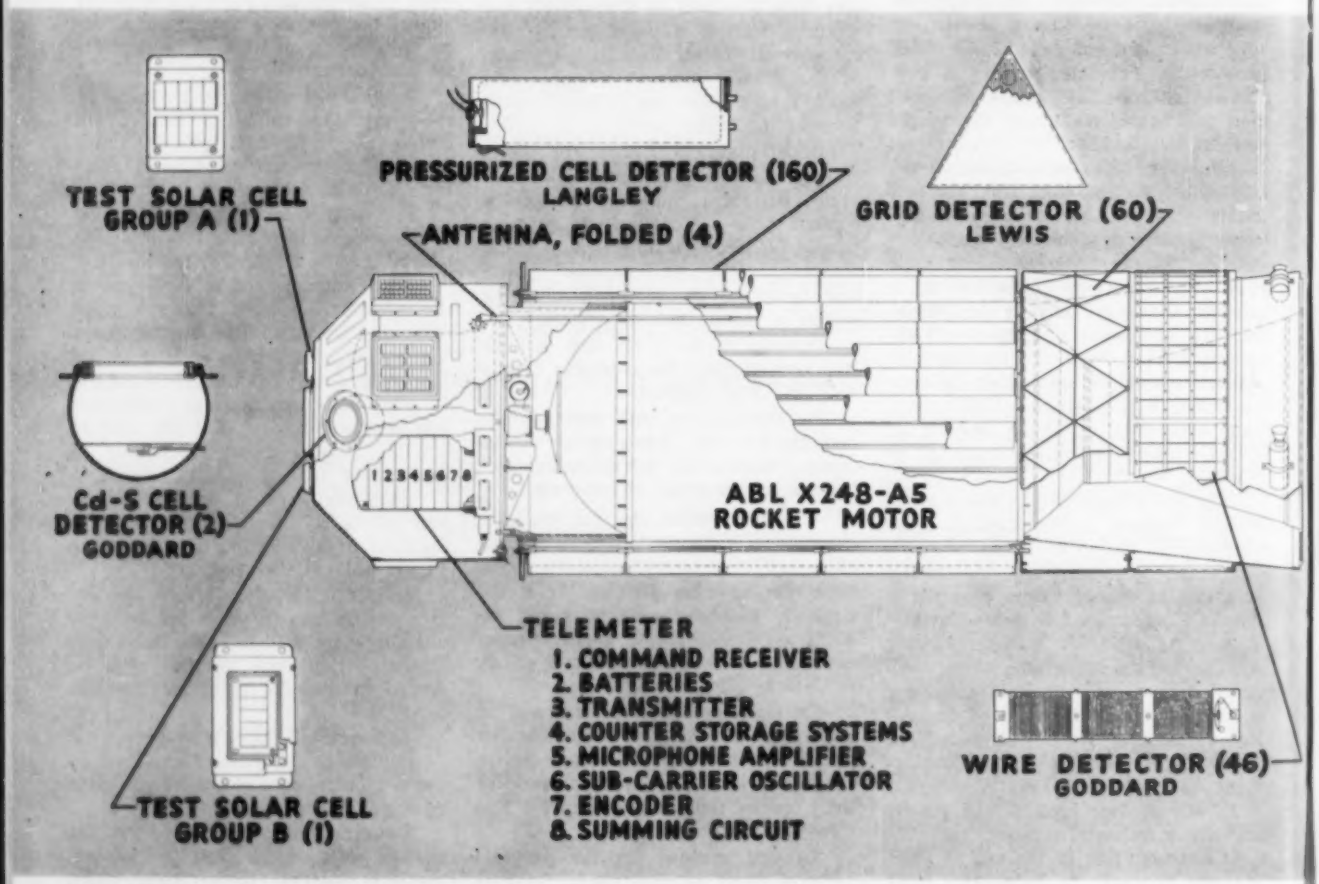
by Hal Gettings

NASA IS preparing an extensive investigation into the micrometeoroid puncture hazard to manned spacecraft, beginning with the launch of an *S-55* satellite—probably this month—aboard a *Scout*.

Today, the damage potential of these tiny high-velocity particles—sometimes called "space dust"—is largely unknown. Yet they pose a critical question affecting every vehicle put into space, in the opinion of M. J. Aucremanne, *Scout* payload project officer.

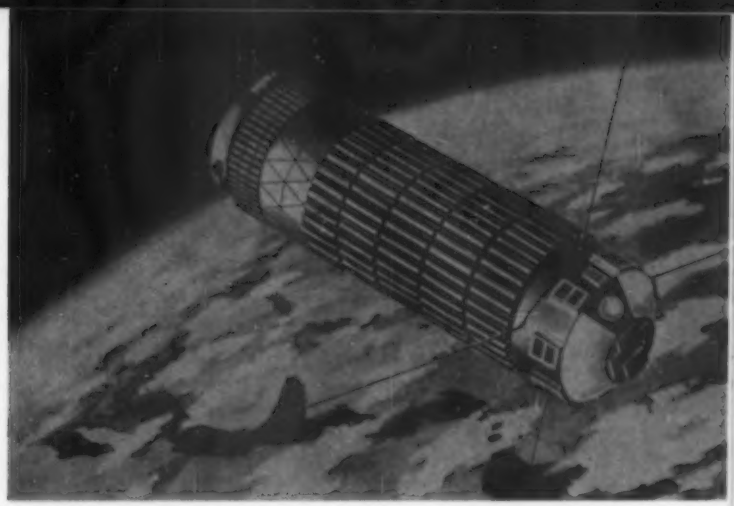
The danger of explosive decompression to a manned spacecraft is only one phase of the investigation. Answers will be sought for structures and propulsion people as well.

The space agency currently is considering follow-on proposals to explore the problems of stabilizing and orienting micrometeoroid data-gathering satellite, optimum orbits and building vehicles with larger surface-area collectors. Some of the later satellites in the program would be fired into polar orbits.



S-55 CARRIES five types of instrumentation to register impacts and penetration of "space dust" particles.

res from 'Space Dust'



Eventually, investigators will try to tie together information gained from satellites with that obtained from ground experiments using hypervelocity guns to simulate meteoroid impacts.

• **Objectives**—The end product, NASA hopes, will answer the "big questions." Are micrometeoroids a real hazard to space vehicles? What are their velocities and penetration capabilities? What is the probability of penetration? Do they exist in "clouds" or are they more or less uniformly distributed? If necessary, how do you shield against them?

It's hoped that *S-55* will shed considerable light on the problem. As presently programed, this first mission has four objectives:

—To obtain direct measurement of micrometeoroid puncture hazard in structural skin samples.

—To measure influx of micrometeoroids having momenta in the range of 10^{-2}, 10^{-1} gm-cm/sec (and higher), and to correlate these measurements with other data.

—To obtain data regarding erosion of spacecraft material due to small particles in space.

—To obtain data regarding action of particles on solar cells and lead to improvements in cell design.

Simply, *S-55's* job will be to find out the size, number, distribution, and momenta of space dust particles.

Five separate measurements will be made by the *S-55* to gather the required data.

• **Sounding boards**—Two "sounding boards" on the nose of the vehicle, connected to microphones, will measure impact levels of particles hitting their surfaces. One will record levels of momentum of 1 gm-cm/sec; the other levels of 0.01 gm-cm/sec.

• **Cd-S cell detectors**—Two cadmium-sulphide cell detectors, also on the nose, provide measurements of erosion due to particle impacts. The cells, covered by aluminized Mylar, detect the level of light allowed to enter as the opaque aluminum is eroded by the cumulative effect of impacts.

• **Pressurized cell detectors**—A series of 160 sealed cylinders, covering the vehicle's midsection, are used to measure the penetration force and distribution of particle impacts. The cells are pressurized to 8 psi with a 9:1 mixture of nitrogen and helium. Particles impacting on the cells with sufficient force penetrate the surface and depressurize the cell. This loss of pressure is detected by a bellows switch and the penetration recorded. The beryllium copper cells are divided into five groups, each with a different skin thickness: 0.001, 0.0015, 0.002, 0.0025, and 0.005 inch.

• **Foil gauges**—Sixty grid detectors, or foil gauges, are arranged around the vehicle's circumference aft of the pressure cells. These detectors are composed of a printed resistance grid covered by aluminum foil. Micrometeoroid impacts of sufficient force break the continuity of the grid, changing the resistance value of the circuit to detect the hit.

• **Wire gauges**—Wire gauges (detectors) perform basically the same function as the foil gauges. In this case, fine wire, wound on cards, detect the particle impacts. Forty-six of these cards cover the after section of the satellite. Fourteen are wound with 2-mil wire and 32 with 3-mil wire.

Information gathered by the cells is stored and transmitted by telemeter on command from a ground station. The telemeter is a dual PDM/FM system, each of which handles half the load. In case one system fails, the other will still provide sufficient data to carry on the experiment.

NASA expects the *S-55* to have a useful life of one year. It will be launched from Wallops Island into an orbit of 38 degrees inclination. Programed perigee is 238 statute miles and apogee 600 miles.

The satellite will not be stabilized and will tumble as it orbits the earth. Later research will study the advantages and problems of stabilization of the vehicle.

• **Hitchhiker**—The vehicle itself is actually the rocket motor of the *Scout's* fourth stage with the cell detectors clustered on its skin. An extension on the motor's nose carries the telemetry, power supply, and other system components. Overall, the satellite is 80 in. long and weighs 135 lbs. The spent motor case weighs 50 lbs.

Primary purpose of the launch actually is a development test of the *Scout*. So the payload is merely a hitchhiker.

Several NASA facilities are cooperating on the micrometeoroid project. Langley Research Center is responsible for system integration and overall project management. Langley also has responsibilty for the telemetering system, pressure cell, and sounding board detectors.

Lewis Research Center is responsible for the foil gauge detectors. Goddard Space Flight Center is in charge of the cadmium-sulphide cell detectors and the wire gauges.

During the first two weeks in space the satellite will be commanded to read out data about three times per orbit. Later, as routines are worked out, it will be commanded only once per orbit.

Data from *S-55* will be acquired by Goddard and sent to Langley for reduction. From there the data from the various experiments will go to the respective Centers for analysis. ⌗

Out There, They're 'Oids'

SELECTION of a proper name for S-55 involved some discussion of the relative merits of "meteorite" and "meteoroid." Although popular usage gives preference to the former, many scientists feel this term properly describes only bodies entering the earth's atmosphere. Thus, to differentiate, those outside the atmosphere are, more exactly, "meteoroids."

$43 million pricetag...

NASA Gets Huge Saturn Launch Site At Cape

But collapse of river lock blocking barge could delay September firing — officials seek other transportation

THE BIG *Saturn* booster is marooned at Huntsville this week.

The trouble: a collapsed lock on the Tennessee River. It is blocking the path of the barge Palaemon, which was scheduled to carry the first *Saturn* booster from Huntsville to the Cape late next month or early in August to meet a first flight date in September.

Unless an alternate means of transportation is found—and NASA officials are frantically searching for one—the *Saturn* firing schedule may slip. For it is expected to take months to repair the bottleneck.

Several huge concrete sections of the lock, situated below Huntsville, shifted June 2, making it impassable for the barge.

Ironically, the mishap occurred just four days before NASA accepted the giant *Saturn* launch complex 34 at the Cape—where the first flight will be attempted.

Any solution to the transportation problem may be costly, since the Palaemon is tied up at Huntsville. This means that even if the *Saturn* booster is trucked to below the broken lock, another barge will be needed to take it the rest of the way. If this approach is taken, the problem is further compounded by having to convert the new barge, because *Saturn* is supposed to be transported in a sealed, air-conditioned container.

• **Complex turnover**—Cost of the new *Saturn* launch complex was put at $43 million as NASA formally took occupancy. Dr. Kurt Debus, head of NASA's Launch Operations Directorate who accepted the facility in an elaborate ceremony, will direct installation of equipment.

Most imposing feature of the new complex is the 310-ft. service gantry. This 2800-ton tower—the world's largest movable wheeled structure—will be used to erect the booster and assemble the upper stages. Each of the tower legs contains a two-story building; these house the structure's operating equipment and rocket checkout apparatus.

The tower has a work deck at the booster base level and seven fixed platforms at various elevations. There are also five movable, horizontally retracting platforms which can be adjusted to embrace the vehicle at any desired level.

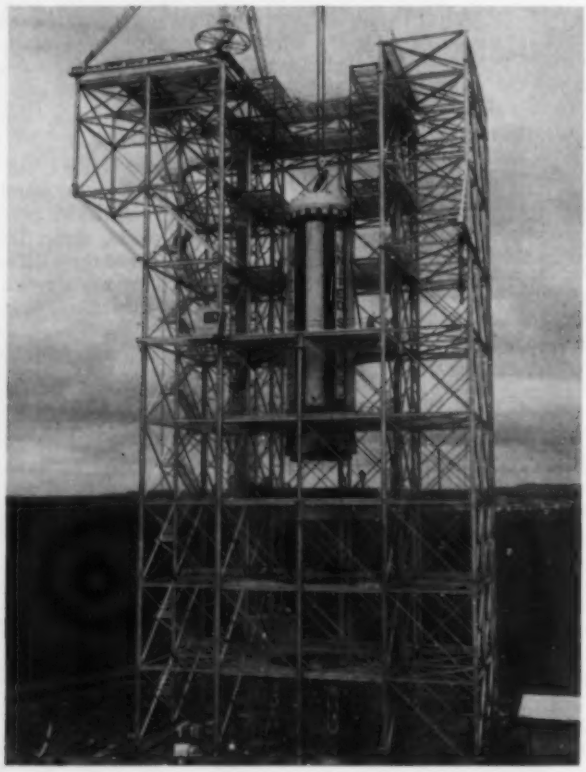
Cost of the structure was approximately $4 million.

The *Saturn* control building is a dome-shaped blockhouse with 12,500 sq. ft. of protected floor space on two levels, and an additional 2150 sq. ft. of unprotected space. It is 156 ft. in diameter.

The inner dome is of reinforced concrete five feet thick. It is covered by a earthfill which varies from 7 ft. in the center to 14 ft. at the edges. The final layer is four inches of gunned concrete.

The first floor of the building will be used by booster and upper stages contractor personnel involved in tracking and telemetering operations.

The main firing operation will be located on the second floor. Equipment includes firing console, test supervision and conductor consoles, and various monitoring and recording panels.



To Test Complete Saturn

DYNAMIC test stand at Marshall Space Flight Center will be used to test and check out the multi-stage Saturn space vehicle. The new structure will also be used to test fueling techniques, ground crew training, and assembly methods.

AERIAL VIEW of completed $43-million launch complex 34 at Cape Canaveral, where first Saturn flight will be attempted.

• **Thick launch pad**—The launch pad is 320 ft. in diameter, constructed of reinforced concrete eight inches thick. In the vicinity of the flame deflector, the pad is paved with refractory brick to protect it from heat. The pad has a perimeter flume for taking away surface water and possible propellant spillage.

A pedestal from which the *Saturn* will be fired is in the center of the launch pad. This structure is 42 ft. square and 27 ft. high.

A rail-mounted flame deflector is located beneath the launch pedestal. This 60-ton steel structure diverts the 5000°F jet stream in two opposite horizontal directions. The deflector is 20 ft. high and 50 ft. long. When not in use, it is parked on rails away from the pedestal. A spare deflector is parked on the opposite side of the pedestal.

The umbilical tower, located adjacent to the launch pedestal, provides electrical and pneumatic lines to the rocket. At present, the tower is only 27 ft. tall. It will be increased in height —up to 275 ft.—as live upper stages are added to the rocket.

Automatic ground control station is a room just beneath a major portion of the launch pad. This room, 215 by 38 ft., serves as a distribution point for all measuring and checkout equipment, power, and high-pressure gas.

A tunnel for personnel, and for passage of a dozen racks of cables, extends from the AGCS to the other side of the pad. The cables are fed into a roofed cableway which leads to the control building.

• **Fuel system**—RP-1 fuel (kerosene) is provided to the booster from two above-ground tanks located about 950 ft. from the launch pedestal. The 30,000-gal. tanks are 15 ft. in diameter. A retaining wall and revetments are provided to retain the fuel should a tank rupture.

An 8-in. fuel line, fed by two 1000 gpm pumps, leads from the tanks to the rocket. Fuel is brought into the facility by truck transporters, three of which can unload at the same time. The fueling operation is completely automatic, operated from the control building fuel loading panels. Normally, the booster will be fueled in about 40 min., although it could be accomplished in about half that time.

A facility for liquid hydrogen, for the *Saturn* upper stage, is to be ready by the time the live upper stages are phased into the program.

There are two liquid oxygen storage tanks some 650 ft. from the launch pedestal. The main vessel is an above-ground sphere with an outside diameter of 43 ft. The tank is surrounded by four feet of "perlite" insulation which controls the evaporation loss of less than 0.5 percent per day. An earth revetment protects the LOX facility on the side of the launch area. A six-inch line feeds the rocket, at a flow rate of up to 2500 gallons per minute. Normally, about 40 min. will be required to fill the *Saturn* booster's five LOX tanks, but it can be done in much less time.

A small LOX tank is used for replenishing the oxygen which boils off during the latter stages of launch preparation. It is a 13,000-gal. tank located near the main tank. A three-inch line, under 200 psi, leads to the booster.

• **H-P gas facility**—A high-pressure facility for gaseous nitrogen and helium is located 1100 ft. from the launch pad and 200 ft. from the control building. This is made up of 36 15½ cu. ft. storage vessels divided into two groups. Four vessels contain helium for bubbling the LOX tanks of the booster to keep the LOX from forming strata of different temperatures. Thirty-two tanks contain nitrogen for purging fuel and LOX lines, engine and instrument compartments, for air bearings, and for certain pressure-operated components such as valves. All these tanks operate at 6000 psi.

Other equipment in the facility includes two helium booster compressor units, which take helium from trailers and boost it to the desired pressure level, and two 1000-gal. trailer-mounted converters to change liquid nitrogen to gas.

A skimming basin is located about 300 ft. from the edge of the pad on the beach side. This is a paved vat, 104 by 180 ft., for the separation of water and fuel resulting from spillage, or from unloading booster fuel.

A water system has been installed on the pad and throughout the service structure, primarily as a safety measure. This provides for fire protection, a "pad flush" system to wash away spilled fuel, and a quenching system for use in case fire occurs in the "boattail" or engine compartment. This system is also used to prevent back-flame from entering the engine compartment in case the engines are cut off immediately after ignition and before liftoff.

An operations support building, now under construction, will contain about 30,000 sq. ft. of floor space for general shop and engineering activities, and spare parts stowage.

A voice communication system is being installed for clear reliable voice transmission regardless of high noise environment. The system will consist of up to 200 stations scattered throughout the 45-acre installation. ■

Morse Attacks Our 'Splintered' R&D

THE "SPLINTERED" approach currently in vogue in U.S. missile/space R&D must end before we can lead instead of lag in the space race, says Richard S. Morse, former Army R&D director.

He blames much of our failure to catch the Russians on lack of national purpose and policy—and lack of honesty in support of certain programs.

In his keynote speech before the 15th National Armed Forces Communications and Electronics Association Convention and Exhibition in Washington, Morse stated flatly that America is steadily losing ground in the technical race with the Soviets. Then in rapid succession he labeled the executive, Congress, industry, and the press as contributors to the present dilemma.

He described five basic causes of splintered R&D:

—The two-party political system (changes in policy and emphasis on programs).

—The three-service military organization (interservice rivalry, duplication).

—The placement of contracts by local need (rather than competence).

—The waste of manpower (on time-consuming but non-productive tasks such as proposals).

—The press (exploiting controversy and failure rather than successes and advancements).

• **It's the system**—Morse softened his verbal lashing somewhat by praising the unpublicized dedication of top military and government personnel. The problem, he said, is not people but the system. And much of the problem is tied in with the "debilitating" influence of the Bureau of the Budget.

He then outlined four recommendations:

1. We must initiate programs and stop attempting always to copy the competition.

2. We must have firm, clear, honest national policy governing our efforts.

3. We must think of and plan for more 10-year programs, then carry them out to fruition.

4. We need some kind of government incentive program, some reward for excellence.

• **Conference expands**—With some 5000 persons attending the AFCEA meeting, and more than 200 exhibits, the meeting was touted as the biggest ever.

It was also the largest electronics exhibit ever held in Washington, said convention chairman Col. W. J. Baird.

Exhibit highlights included three from the military. The Navy demonstrated some of its NAVSPASUR (Space Surveillance System), designed to detect, track, and identify all non-radiating space objects within its range.

The Air Force showed its Combat Logistics Network (COMLOGMET), due to be integrated in the Aerospace Communications Complex in 1962.

The Army provided a good look at its *Advent* (see p. 13).

• **New hardware**—Hoffman Electronics Corp. revealed its new retractable whip-type antenna. Designed for use on submarines and hardened missile sites, it offers a method for covering all radio frequencies from 2-32 mc.

Designated the WRA-2, it uses a helix coil which is a physical part of the antenna to change the electrical length of the system. Peak power capability, the company said, is 5 kw.

Also displayed was General Electric's new image orthicon tube which serves in a combined optical-radar system for missile detection. GE says the units can detect a 2-ft.-diam. black sphere in sunlight 2000 miles away. ⌗

Martin Reveals Advanced Voice Communications

A REVOLUTIONARY voice radio communication system capable of handling 700 two-way conversations simultaneously on one single-frequency channel has just been unveiled by Martin-Orlando.

G. T. Willey, vice president and general manager of the division, says that the system—called RACEP, for random access and correlation for extended performance—is "probably the most significant development in the field of voice communications electronics since the end of World War II."

He sees wide future application in all types of military and commercial communications, including future satellite relay systems.

According to Willey, the mobile radio telephone system provides major gains in spectrum efficiency, transmission reliability, and operational flexibility. As an example of the spectrum-saving features of RACEP, he said that in the area of air traffic control communications alone, he could foresee a reduction of 70-85% in future frequency requirements.

• **New method**—The RACEP system achieves its high performance with a new type of voice-actuated pulse-modulation technique. Voice signals are broken down and coded into microsecond fragments, mixed with similar signals from as many as 700 other circuits, and all transmitted at once over the same channel. Special receivers, preset for the proper code of a specific conversation, receive that conversation and reconstruct its fragments back to normal speech.

The equipment is the equivalent of a private radio telephone system which has all the operating characteristics of an ordinary telephone system without the use of wires or central switchboards. A subscriber can "dial" any other subscriber and talk privately with no interference.

In more technical detail, the speech waveform is sampled and converted to a modified form of pulse-position modulation (PPM). Each PPM pulse is address-coded by transmitting it as a group of sub-pulses, each sub-pulse being transmitted at a different carrier frequency. Time delays corresponding to the desired address code are inserted between the sub-pulses prior to transmission.

At the receiver, detection of a transmitted pulse group is accomplished by envelope-detection of each sub-pulse and insertion of complementary delays followed by coincidence-gating. Therefore, all sub-pulses must be present in the proper time slots for the full PPM pulse to be present at the output of the decoder. The pulses at the decoder output are fed to a nonsynchronous PPM demodulator which regenerates the original speech-input signal.

The use of pulses very narrow in relation to the sampling period allows many signals from different transmitters to occupy the same common frequency channel with only a small amount of mutual interference or crosstalk. Minimum pulse-density, and therefore minimum crosstalk for a given number of users, is achieved by using nonsynchronous PPM and voice-actuated transmission.

• **Reducible**—Present models of the RACEP discrete address units are 14 x 14 x 12 in. and weigh less than 35 lbs. Battery-operated from a 24-30 vdc supply source, power consumption is less than 200 watts. Units can be mounted in vehicles or man-carried for mobile use. If required, Martin says, the RACEP units can be reduced considerably in size, weight, and power consumption. Capacity and range are expected to be increased with further development. ⌗

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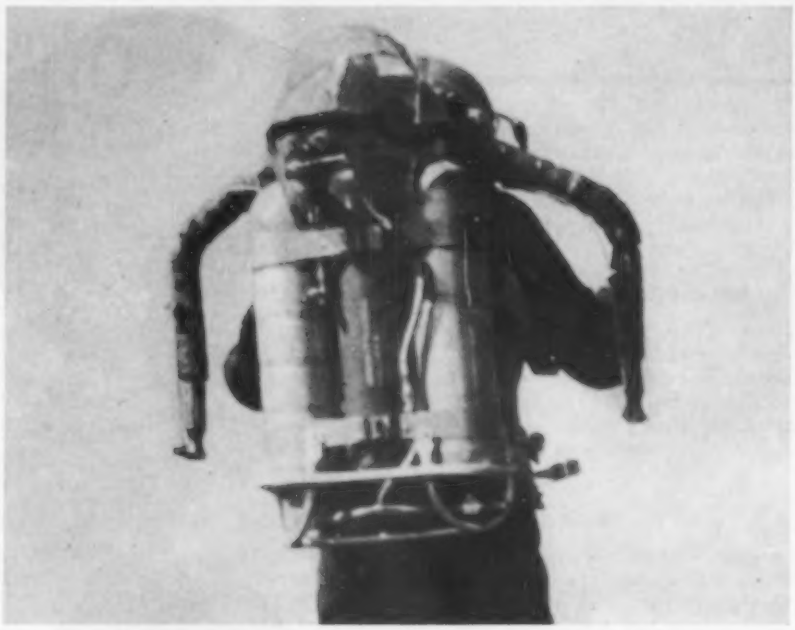

LOCATION of exhaust nozzles away from body makes protective devices unnecessary.

AN EXPERIMENTAL rocket belt, capable of flying a man up to 360 ft. distance at 3 to 4 ft. altitudes, has been developed by Bell Aerosystems Co., under an Army Transportation Research Command contract.

System weight and performance details were not disclosed, but test engineer H. M. Graham, who has made all of the free flights, weighs 180 lbs. before strapping the small rocket lift device (SRLD) on his back.

The unit is a feasibility model and is not designed to meet specific military requirements. Basically the system consist of a twin-jet H_2O_2 propulsion unit mounted on a fiberglass corset. Metal control tubes extend forward on each side of the operator. One tube controls the flight direction and the other the rocket thrust level.

Pitch and roll are easily controlled by the operator's body. When activated by the pilot, H_2O_2 is forced under pressure into a gas generator, where contact with a catalyst decomposes it to steam. Main thrust is provided by the steam through two nozzles directed toward the ground.

Jet deflectors provide thrust for yaw control when the operator needs it. Nozzle positions and exhaust temperatures eliminate the need for protective clothes to shield the operator. ⌗

HURDLING a fire truck is no problem, and 30-ft. hills are just as easy.

GRAHAM navigates a creek with the Army-sponsored feasibility unit.

HILL-CLIMBING with the versatile SRLD saves considerable shoe leather.

Said Isaac Newton:

"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."

Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

These principles have made possible the early development of the MIDAS satellite. Moreover, they substantially increase the altitude and payload of the DISCOVERER series. Lockheed, Systems Manager for these programs and for the POLARIS FBM, is pursuing even more advanced research and development projects. As a result, there are ever-widening opportunities for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-15A, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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Technical Countdown

ELECTRONICS

Star Atlas Under Study

Eastman Kodak is "building" under Army contract an infrared star atlas for space navigation. Using highly sensitive IR sensors and the 69-in. reflector at Ohio University, researchers already have obtained stellar data in the middle wavelength range of the IR spectrum. New equipment under construction will record far IR with larger telescopes. The first phase—charting only known stars—will be completed in six months. "Cold" stars will be sought in later studies.

Computers Being Further Minified

A space computer using functional solid-state circuitry is being developed by Westinghouse Air Arm Division. Such molecular units will be employed, Air Arm says, to perform most of the electronic operations—switching, amplification, and other logic functions. A unit will weigh under 15 lbs. and occupy less than 0.33 cu. ft—well over a 10:1 size-weight reduction.

Satellites to Test Electronic Components

Project *Relay*, as a side mission, will explore the technological problems of active electronic systems operating for long periods in space. Of special interest is the effect of radiation on the components of such systems. Life history of components in the *Relay* communications satellites will be measured both by overall performance and by individual characteristics of a number of selected critical units.

SUPPORT EQUIPMENT

Cross-country Computer Link Converted to Tape

Conversion to magnetic tape has doubled the capacity of Douglas Aircraft's transcontinental data transmission system. The tape-to-tape system—which can handle 300 characters per second over telephone lines—connects an IBM 1401 computer at Charlotte, N.C., with a 7090 at Culver City, Calif. The 2200-mile high-speed data link provides the Charlotte plant with direct access to the big 7090 computer, to solve problems in design and development of *Nike* missiles.

3-D Display in Development

The Air Force is funding development of a unique three-dimensional display for possible application in manned weapon systems. The contractor, ITT, has already demonstrated a model of a company-sponsored volumetric 3-D display which can be viewed from all sides and above without the use of special stereoscopic eyeglasses.

Dean Space Drive Hits Air Pocket

The controversial Dean Space Drive which purportedly changes rotational energy into a unidirectional force without the drawbacks of external reactions underwent an analysis last month under an Air Force contract (see p. 24). Contractors' conclusion: The Dean Drive will never get off the ground.

ADVANCED MATERIALS

Laser Metalworking Successful

Lasers have been used by scientists at Trion Instruments, Inc., to punch holes in razor blade compositions and foil. The device also offers promise in the field of microspectroscopy, since the high-intensity beam vaporizes all materials in microseconds. Non-destructive analysis operations would be possible on the production line. The firm is working on a continuously operating laser for such applications.

Electron-Beam Strip Annealing Developed

Temescal Metallurgical Corp. has developed a continuous-annealing furnace which uses electron-beam heating in high vacuum. The strip passes through the furnace, unwinding and rewinding in air at each end. The furnace will have broad applications in processing reactive metals such as tantalum, columbium, titanium and zirconium.

Filament-wound Cases Cheaper

Missile and rocket-motor cases of fiberglass and wire filaments would cost 60% less to manufacture than metallic cases of comparable size, according to a study by Aerospace Corp. Engineers there also pointed out that solid-propellant vehicles currently under development now outnumber liquid systems.

Needed for further development, the report said, are improved methods of creating uniform strength in fiberglass and wire filaments and new advancements in filament-winding technology. Further study of plastic and metal laminates as potential motor case material is recommended, but all design and stress problems encountered must be thoroughly tested under actual service conditions.

New Process for Pershing

Martin Co. has developed an inexpensive technique for protection of the *Pershing* nose cone, requiring no new tooling or facilities. The ablative insulation composition and manufacturing methods were not disclosed, but it is known that the technique reduces weight.

Beryllium from U.S. Ores

A joint agreement between Beryllium Corp. and United Technical Industries will lead to fabrication of beryllium metal from domestic ores. Initially, the firms will operate a plant nearing completion in Delta, Utah, drawing from UTI's holdings in the Spors-Topaz Mountain area.

Material Toughness to be Doubled?

Material strengths as high as 500,000 psi—double that available today—may be achieved within the next decade, a NASA expert has predicted. One of the primary problems being researched: how to attain the desired toughness without an accompanying brittleness.

Continuous-Action Viscosimeter

The Russians have perfected a continuous-action viscosimeter based on the principle that viscosity is determined by measuring the attenuation of natural oscillations of a magnetostrictive probe immersed in the liquid. The instrument permits automatic and remote measurement of liquids, both at rest and during flow.

Consultant's Report Overrides Dean Sp

Model analysis carried out for Air Force finds machine depends on rigid reference, qualifies only as inferior impact or vibration unit

by William Beller

AN AIR FORCE consulting engineer is raising a question whether the controversial Dean Space Drive—a mechanical anomaly which would amend one of Newton's laws—will ever get off the ground.

The drive is described by its inventor as one in which "energy . . . is converted into force capable of acting in any given direction on a given load without reaction occurring exterior to the system or load . . ."

If it worked, the machine could provide a means of vertical motion without ground support.

But an analysis of a model provided the AF Office of Scientific Research says it isn't so. In a report to OSR, Rabinow Engineering Co., Washington, D.C., says the "machine can move weights only when there is a rigid reference to provide the reaction necessary for the operation of the machine."

Norman L. Dean, the Washington inventor of the Space Drive, has been trying to interest the military and industry in the device for more than a year (M/R, May 1, p. 24). He has succeeded in baffling almost everyone who looked at a working model. No one up to now would say for certain whether it would or would not work.

Finally, OSR this April handed the problem over to Rabinow for a solution. Late last month, Jacob Rabinow, principal investigator and inventor of the electromagnetic clutch concluded that:

—The system does not have any unusual properties nor does it contradict Newtonian laws of mechanics.

—The system may have application as an impact machine or vibrator but can not produce a unidirectional impulse without an equal and opposite impulse. However, the device tested is not an efficient design for an impact or vibration machine.

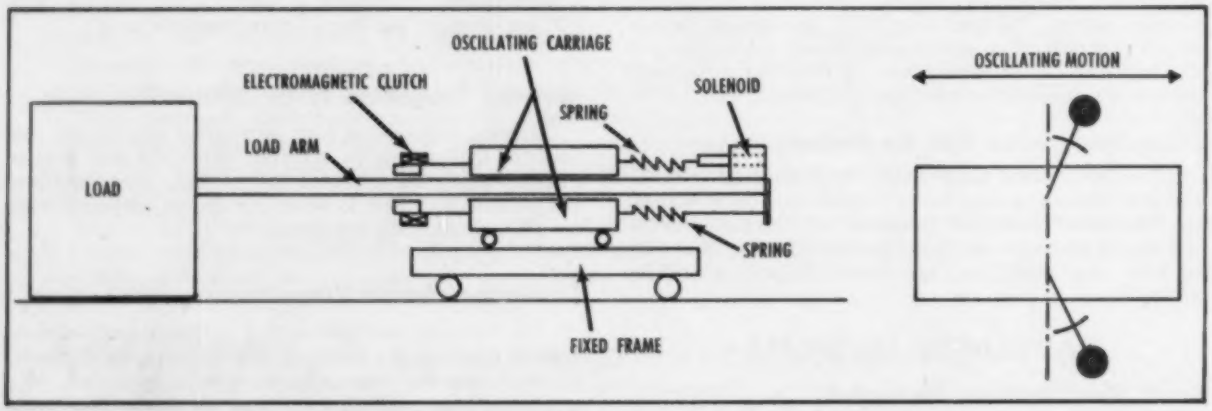
—The demonstration device gives the illusion of generating a force without an equal and opposite reaction by making use of the static friction of the load against the floor—or other support—to absorb the reaction. It cannot perform as claimed in the absence of static friction on an outside reference body.

—There is no way in which the principle employed in the device can be adapted to provide a "space drive." The U.S. patent—No. 2,886,976—awarded to Dean shows a straightforward oscillating mechanism which can produce unidirectional motion only when associated with a stationary reference body.

Queried by M/R on these conclusions, Dean insisted that Rabinow's analysis was not correctly made.

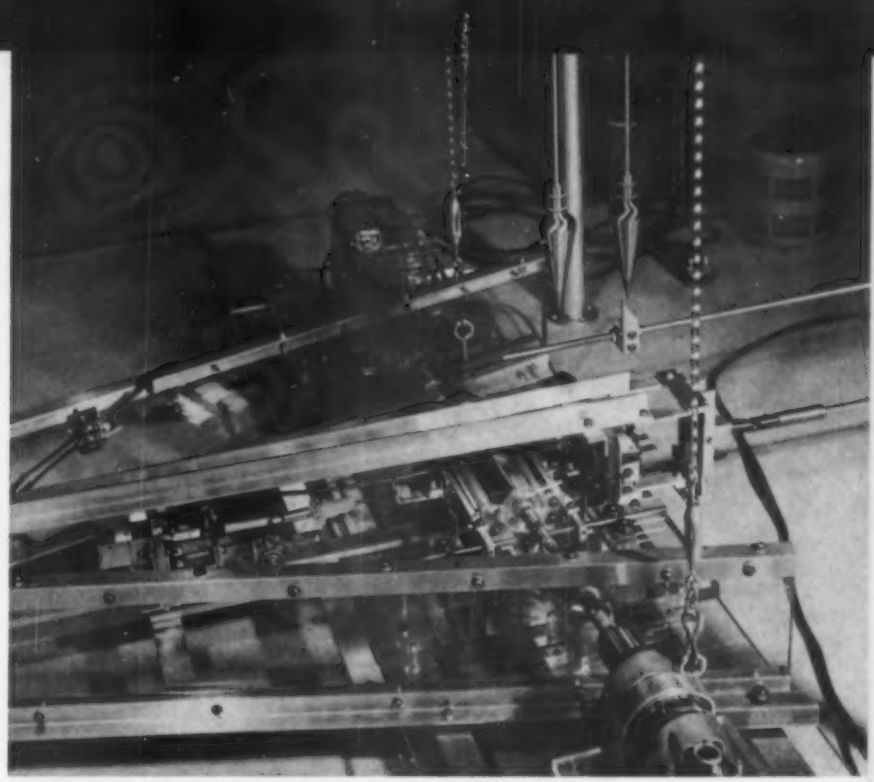
• **How it works**—The model Dean supplied has five essential components: an oscillating carriage, a load and connecting arm, means for coupling the load arm to the oscillating carriage, two electric motors geared together to act as one, and a fixed frame.

Oscillating carriage. Constrained to



LEFT: Schematic diagram of Dean's demonstration model. RIGHT: Schematic of the oscillating carriage.

Space Drive



MODEL OF DEAN DRIVE is suspended pendulum-fashion from an overhead truss.

move only a short distance back and forth along the load-arm axis, the oscillating carriage contains two equal and counter-rotating eccentric masses. These put forces into the carriage which are always co-linear with the load arm. This is done by gearing the masses together so that the load arm is the masses' axis of symmetry.

In the Dean model, the eccentrics weigh about ½ lb. each and have a mass unbalance of ¼-in.-lb. each, Rabinow reports. The carriage, complete with eccentrics, weighs about three pounds. Total movement of the carriage, including travel, is limited by stops to a little over an inch.

Load and arm. The load and connecting arm are said to act essentially as one body. The load arm is described as a rigid member mounted on ball bearings on the fixed frame. It can have a free displacement of about 1½ in. with respect to the oscillating carriage.

Coupling. The oscillating carriage is coupled to the load arm by three separate means: electromagnetic clutch, solenoid-operated spring bias, and a fixed spring bias.

Once every cycle, the clutch and the solenoid are separately energized. The clutch grasps the load arm when the eccentric weights are rotating on the far side of the load. They exert a force on the carriage which—through the clutch—pulls the load. Rabinow says that the clutch tested was able to transmit up to ten pounds of force without slipping.

The solenoid, which has a stroke of 5/16 in., acts for only a short time and applies a spring bias which tends to push the load and the carriage apart. On the other hand, the fixed spring bias applies a smaller force but over a longer period.

The magnitudes of spring biases depend on the relative positions of load arm and oscillating carriage. Rabinow says that the free lengths of both springs are such that they are uncoupled at extreme separation between load and carriage.

Drive mechanism. The eccentric masses are driven by two electric motors coupled together. Sliding universal joints transmit the torque from the motors to the oscillating carriage without interfering with its motion.

Fixed frame. The fixed frame is the base for the oscillating carriage, load arm and drive motors. For demonstration, it is suspended as a pendulum from an overhead truss. Rabinow observes that since the frame is coupled to the load and carriage only through low-friction bearings and a flexible drive, it is not part of the dynamic system.

• **Exterior reactions shown**—Rabinow ran several tests with the model. In the first ones, he attempted to show operating principles and the "apparent" violation of Newton's third law.

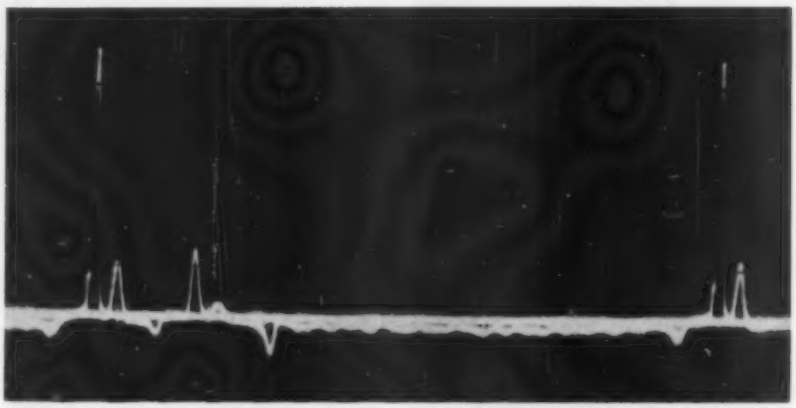
Here are the conditions described: pendulum suspension, fixed frame horizontal; external load consisting of a 19-lb. block of aluminum supported on a level, stationary aluminum base-plate; static friction between load and base-plate, 5 to 6 lbs.; moving friction, between 3 and 4 lbs.

In operation, the load is said to be drawn toward the unit in a series of step-wise motions. "Meanwhile," Rabinow observes, "the (fixed frame) and contents, suspended as a pendulum, remain undisplaced from (the) vertical position.

"During the first few cycles the (carriage) moves toward the load until a point of stable operation is reached. Thereafter, the mean position of the (carriage) follows the motion of the load until the motion is limited by the (carriage) hitting the fixed stops."

In the second test, the friction be-

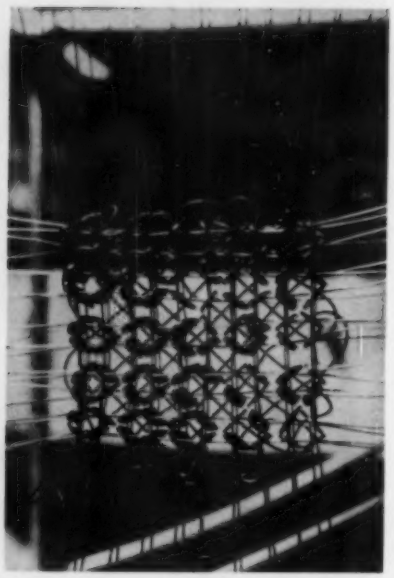
(Continued on page 42)

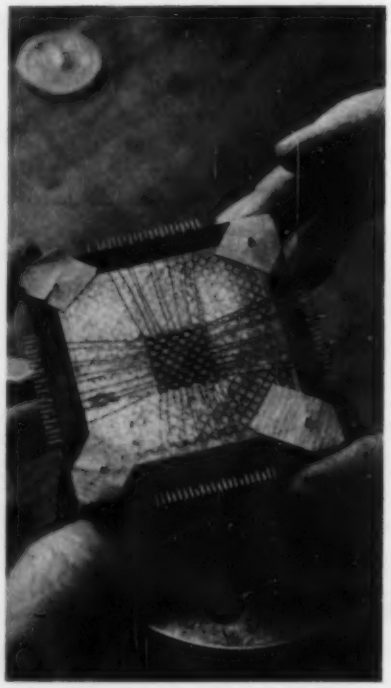


STRAIN ON LOAD BAR causes this Force vs. Time oscillogram. Fact that negative area is approximately equal to positive area shows that momentum is conserved.

IBM Turns Out Record Storage Unit For OAO

by Charles D. LaFond





TOP: *A close-up of an experimental configuration of one MARS plane under construction. Two days are now required for hand-wiring each plane. By November, the operation will be automatic and each machine will do the task in two hours.*

CENTER: *Tiny ferrite cores such as these will be the key memory elements in a new satellite for command and primary storage. Where conventional core memories erase electronically by reading, these unique two-hole cores can be interrogated over and over without destroying information stored in them.*

BOTTOM: *NASA's Orbiting Astronomical Observatory will use the newly developed non-destructive ferrite core as the heart of the data storage and processing system being developed for the satellite. Here, being assembled into 64x64 core planes for preliminary test at IBM's Space Guidance Center, Owego, N.Y., are the tiny MARS devices.*

OWEGO, N.Y. — A breakthrough has been made in spaceborne data memories with development of a nonrotating, nondestructive readout, random-access storage device.

The lightweight, low-power system is dependent upon tiny multi-aperture reluctance switches employed as memory elements.

Currently under development by International Business Machines Corporation's Space Guidance Center here, the device will find first use in NASA's Orbiting Astronomical Observatory *(OAO)*.

This is the massive spacecraft carrying telescopes and a super precise stabilization system which will be built by Grumman Aircraft Engineering Corp. for launch in late 1963 or early 1964.

IBM's high-speed unit is believed to be the largest random access memory of its kind and involves three years of work. Highly advanced redundancy techniques will be used to insure against failure during the satellite's year-long operational period.

• **New memory element**—Curt Johnson, general manager of IBM's Space Guidance Center, says the development represents the "interim storage element before bionics" takes a foothold in tomorrow's information handling systems.

Called MARS (for Multi-Aperture Reluctance Switch), the basic element is a substantially improved transfluxor-type device.

In studying a phenomenon known as inner-wall reflex switching, and other switching mechanisms common to multi-apertured ferromagnetic devices, scientists at the Center discovered a control technique they call "inner-wall pulse bias." This, they said, provided the supplementary control variable which led to the final development of MARS.

Mechanically, MARS is characterized by two small apertures having about the same inner perimeter. IBM felt it was necessary to eliminate the need for a large aperture—which typifies the classic transfluxor—before a practical three-dimensional coincident current, non-destructive readout memory could be developed.

The new element has these attributes plus:

—Half-select currents required for the read and control operations are of equal magnitude.

—Speed capabilities for read and store modes are at least equal to that for a 3-dimensional toroidal-core memory element.

—Unusually small size permits matrix densities of a minimum of 3000 bits per cubic inch.

—Reproducibility and handling offer no obstacles to future use.

• **MARS assembly**—IBM assembles the elements in 4-inch-square planes, each handling 4096 bits. Twenty-five of these can then be stacked to provide a complete 4-wire MARS matrix array. The result is a storage unit providing a 3-D Random Access Non-Destructive Advanced Memory (called RANDAM). It can be instrumented with no more selection or driving means than already required by a conventional 3-D toroidal core matrix. A complete 4-inch-cube assembly has a 102,400-bit capacity.

• **OAO application**—Culmination of the early design work came with the award of the subcontract for a data processing and storage system by Grumman for its *OAO* satellite program.

The work began last Dec. 1 and developmental portions of the system are already undergoing test operation.

RANDAM appears to fit all the unique requirements of *OAO*.

• **OAO instrumentation**—The supporting electronics, stabilization, and control subsystem for *OAO* represent a sizable portion of the payload.

In addition to the experimental packages, command receivers and transmitting equipment, the system will employ a highly complex hybrid stabilization and control system. The electronic link connecting all of these major subsystems is IBM's data storage and processing system.

Under a recently announced subcontract to Grumman, General Electric's Missile and Space Vehicle Department in Philadelphia will develop the stabilization and control for the spacecraft. It will employ coarse and fine control subsystems. Initial alignment will be with a set of large (coarse) inertial flywheels and gas reaction jets for 3-axis maneuvers and hold. Inputs will be from solar sensors and by ground command.

This first alignment will be to a pointing accuracy of within ±1 minute of arc.

The secondary control system will be designed to permit fine angle adjustment to within 20 seconds of arc. To achieve this, six precision star trackers will be used—one at each end of the vehicle and one on each of four sides. Pairs of these star trackers will be oriented to provide corrections for each gimbal angle.

A second set of reaction wheels will be used—one wheel at a time—to gently slew the craft into the desired position. The reaction wheels will be under the control of the star trackers in all but one of NASA's experiments. (The whole system, reportedly, will include a capability for telescope resolution to within 0.1 second of arc. Details on how this will be accomplished are not now available, although some form of radio-inertial guidance and control actuation may be employed.)

• **Data processing**—The IBM memory and data processing will provide readout of observed data or status information at rates up to 100 bits per millisecond. Readout, using the new multi-aperture ferrite core memory, will be provided to the ground at bit rates of either 16 kc or 1 kc.

More than 200,000 data bits can be transmitted to ground in about 7.5 seconds. Since readout is nondestructive, content of the entire memory can be transmitted repeatedly during the time that line-of-sight contact exists, or for up to roughly 10 min.

The memory capacity of the new system is believed to be the largest of its type known to be under development for space use.

The same capacity could be achieved, said IBM, with other devices such as magnetic drums or tape. However, these are rotating devices whose motion would disturb the vehicle's position accuracy.

Other existing non-rotating memories, capable of similar repetitive data transmission, would require prohibitive space, weight, and power-consuming equipment.

The data processing subsystem will consist of five principal units: the command decoder and distributor, the programer, the system clock, command storage, and the delay line logic.

The first serves as the prime input link, verifies and decodes radio ground commands, and redirects radioed and stored commands as required.

Command storage, also non-destructive, holds data received from ground stations for upcoming operations.

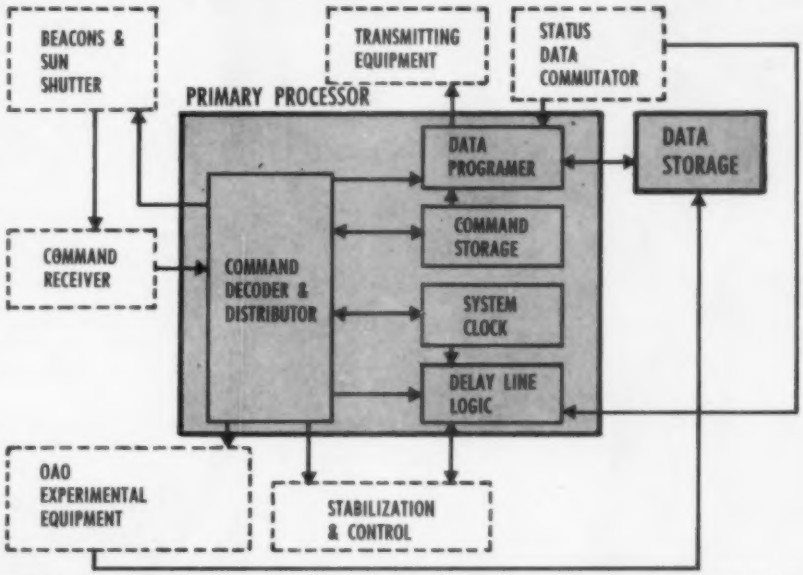
The data programer collects digital data and prepares it for main memory storage. These data later will be telemetered to the ground.

• **Multiple redundancy**—A timing generator and time-compare logic in the system clock provide output signals to sequence stored commands from the associated command memory unit.

Digital control to the stabilization and control subsystems will be provided by the delay line logic.

In the main data storage unit, capacity in flight will depend on memory degradation. Initially, the entire 204,800 non-redundant bits may be used for storage.

With time there will be failures, and the package may be switched to result in a 102,400-bit (redundant) memory. Storage rate is from 0 to 2.5 million bits/sec. for 25 binary-bit parallel input.



HIGHLY SIMPLIFIED block diagram shows how IBM's Primary Processor and Data Storage serve as connecting link for all of OAO's electronic subsystems.

The whole system employs quadruple component redundancy and triple modular redundancy. Importantly, while system provides nearly quadruple overall redundancy, fabrication will result only in 1.5 times increase in weight. IBM says the total system weight of 130 lbs. represents a 4:1 decrease over other comparable systems, due primarily to the packaging techniques employed.

System power requirements are estimated at about 30 watts average with a peak requirement of 59 watts. Power savings are effected, since only those units required for operation are energized at any given time.

To help assure continued operation for the full year of planned use, mean-time-between-failure design goal of 0.89 has been set. System models now under test (8000 hours so far) have indicated a reliability of at least 0.875. ■

LIGHT-WEIGHT UNCOOLED ROCKET NOZZLE

This drawing is representative of advanced material systems application in high-performance solid rocket nozzles.

1 TUNGSTEN LINER resists 5000-6000°F flame temperatures and high mass flow erosion forces.

2 DIFFUSION BARRIER, stable carbide interface, prevents diffusion of carbon into tungsten and eliminates gas pockets between liner and heat sink.

3 GRAPHITE HEAT SINK provides rapid absorption of heat from liner into graphite. Shape is a function of application requirements.

4 CERAMIC INSULATOR presents a high-temperature thermal barrier to restrict heat transfer into plastic insulation.

5 PLASTIC INSULATION serves the dual purpose of preventing overheating of outer wall and adds rigidity to the system.

6 FLANGE AND SPLINE ASSEMBLY of high-strength alloy provides axial load distribution and allows nozzle to be assembled from the inside out.

7 OUTER SHELL of filament-wound plastic provides maximum efficiency on strength-density basis.

MARQUARDT—The Qualified Source for Complete Rocket Nozzle Systems

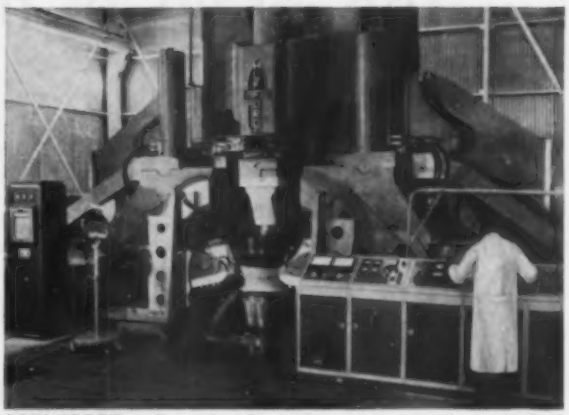
Marquardt's continuing programs of research, development, and fabrication in the ultra-high temperature areas of refractory metals, metal reinforced ceramics, and other composite materials provide a single, complete source for complex rocket nozzle systems. This capability is fully documented by a proven record of materials engineering, processing, and production accomplishments.

Marquardt's unique ability to produce intricate components and systems for the aero-space and defense industries is substantially supported by company sponsored research programs in manufacturing operations. New levels of efficiency and economy in fabricating techniques are tangible results of these programs. Development studies are presently being conducted in high-energy forming of tungsten sheet into radical shapes impractical to form by standard processes; in improving techniques in welding pure tungsten sheet; in producing spin forged tungsten castings and forgings on a high-volume basis.

Significant materials and manufacturing achievements at Marquardt include the development and production of spun tungsten rocket nozzles; a wide variety of nozzle liners and parts; fixed and variable afterburner nozzles; complex attitude propulsion systems and controls; and ramjet nozzles.

Sixteen years of technological experience gained in research, development, and production of a broad range of power systems for atmospheric and space flight are important benefits offered by Marquardt engineers. This leadership combined with extensive facilities provides an exceptional capability for the development and production of reliable high-temperature materials and structures. Detailed information about Marquardt's advanced manufacturing capability may be obtained by writing Corporate Director-Marketing, The Marquardt Corporation, 16555 Saticoy Street, Van Nuys, California.

Engineers and scientists experienced in these or related fields will find it rewarding to discuss career futures with Marquardt. All qualified applicants will receive consideration regardless of race, creed, color, or national origin.



SPIN FORGE — Capable of exerting an accurately controlled million pounds working force, this Spin Forge flow forms seamless components up to 5 ft. in diameter and 15 ft. long.

EXPLOSIVE FORMING — This process makes possible the volume production of heretofore impractical-to-form shapes with tolerances difficult to attain with conventional methods.

TM-1 TEST MACHINE — The auto-dynamic elevated temperature test machine conducts tensile, creep, stress-rupture, compression tests of metals at temperatures up to 5000°F. Programming of mission load-temperature-time parameters may be performed.

THE Marquardt CORPORATION

CORPORATE OFFICES, VAN NUYS, CALIFORNIA

ASTRO ◆ OGDEN DIVISION
◆ POMONA DIVISION
◆ POWER SYSTEMS DIVISION

The 'Brain' of the Polaris Missile

Guidance package designed by MIT lab is smallest of inertial systems in present operational missiles

by R. B. Walter

Inertial Guidance Mechanical Engineer, Ordnance Department, General Electric Company, Pittsfield, Mass.

MK I POLARIS inertial guidance system. Shown with the system are the heads of the original design team from Massachusetts Institute of Technology's Instrumentation Laboratory, Ralph Ragan (left) and David Hoag. The same group is now developing the Mk II system for the 2500-mile-range Polaris A-3.

THE *POLARIS* inertial guidance system—only one small component in the Navy's complex Fleet Ballistic Missile Weapon System—plays an immensely vital role in the system's ability to deliver deadly payloads to targets from 300 to 1200 nautical miles away.

Designed (and conceived) by the Instrumentation Laboratory of Massachusetts Institute of Technology, improved versions of the guidance package are already in operational missiles (*A-1*) on station. Further improvements will be reflected in units now being developed for the 1600-mile-range *A-2* FBM.

A redesigned version incorporating the latest state-of-the-art techniques also is in R&D now for the future 2500-mile *Polaris A-3*.

With all the improvements, however, new systems will still be evolutionary embodiments of the present system.

This smallest of all inertial guidance packages used today in operational ballistic missiles was built by the Ordnance Department of the General Electric Company, Pittsfield, Mass.

Designed for launch from submarines well below the sea's surface, the missile is a two-stage, solid-propellant IRBM. After thrust termination of the second stage, the path of the nuclear warhead is a simple ballistic trajectory.

The inertial guidance system is in full control of the second stage up to separation; thus all of its work is accomplished in something less than 60 seconds. First stage up to termination is controlled by an autopilot only.

Within the missile's equipment section, located between the payload and the second-stage propulsion unit, is the guidance system—a stable platform and computer, which, together with the autopilot and programer, guides and controls the missile during the first and second stages of flight. The guidance equipment, contained completely within the missile, has no dependence on the launching vehicle (submarine) after firing.

Using extremely precise gyroscopes, accelerometers and the missile-borne electronic computer, the guidance system puts the missile on correct course at the time of the launch. Should the missile be moved off course by high winds or other effects, the guidance system automatically computes a new correct course and puts the missile on it.

The guidance system also maintains the stability of the missile in pitch, yaw and roll planes. At the precise instant required, the guidance system shuts off the rocket motors and triggers separation of the re-entry body from the missile, The re-entry body then follows a ballistic trajectory to the target.

The guidance subsystem is composed of an Inertial Reference Unit and a computer. The IRU consists of a stable platform and platform electronics, including the servo amplifiers. The digital computer is housed in an electronics unit. The servo amplifiers and power supplies are physically packaged with the computer.

• **Inertial reference**—The primary function of the Inertial Reference Unit is to provide a stable three-axis reference for three accelerometers. A secondary function is to provide attitude reference information to the flight control subsystem. The IRU employs three gimbals, and its inertial components are mounted on the innermost gimbal, or stable member.

The principle of inertial navigation is conventional: the measurement of acceleration by means of a linear accelerometer, integrating once to obtain velocity and again to obtain distance. In the *Polaris* guidance application, velocity signals are required by the computer. The accelerometers are stabilized to local horizontal and vertical before launch, on a gyro-controlled platform. The gyros and accelerometers remain fixed in this orientation in inertial space during flight.

The stabilization of the inner gimbal is provided by gimbal servos, using the gyros to detect any motion of the inner gimbal about any axis and the servos to restore the gimbal to its original position.

• **Inertial components**—The gyros used are inertial rate-integrating, single-axis, floated models. Although exact figures are still classified, drift rate of the gyros is very small.

The accelerometer used is also designed around a gyroscopic principle: that the precession rate of a gyro is directly proportional to applied torque. In the case of the pendulous integrating gyro accelerometer (PIGA) the torque

is provided by a known fixed unbalance of the float about the gyro output axis and the acceleration to be measured. The angular rate at which the accelerometer revolves about its output axis is directly proportional to acceleration along the input axis.

The gimbal servo amplifiers and the PIGA servo amplifiers, plus the necessary servo and platform power supplies and excitation voltage sources, comprise the platform electronics.

• **Computer control**—The *Polaris* inertial guidance system uses a digital computer. Primary function of the missile-borne computer is to accept the velocity outputs of the three PIGA's, combine these with quantities set in by the submarine's Fire Control System before launch, and compute the necessary command signals to insure that the missile hits target within a specified accuracy. These output signals are the thrust termination command, a pitch-steering command, a lateral-steering command, and a pre-arm command.

• **Pre-launch inputs**—Before missile launch, the guidance system depends on the Fire Control System for platform alignment, erection, trajectory coefficients, velocity information, and firing bearing.

The launching of a guided ballistic missile from a ship or submarine to a selected target requires precise determination of the geographical launching position, true north, the ship's linear and angular velocities, earth's rate, and local vertical. These are provided by the SINS (Ship's Inertial Navigation System)—basically a 5-gimballed, gyro-stabilized, inertial-navigation platform with suitable electronic and electromechanical gear for performing the necessary integrations and computations. The SINS is aided, in its accuracy, by systems for periodically checking the position of the ship with respect to shore stations, celestial trackers, and monitoring systems to check the calibration of SINS gyros and detect malfunctions. (For details of the SINS, refer to M/R, July 25, 1960, p. 24.)

Fire Control performs the many tasks necessary to prepare the missile guidance system for the moment of launch. It is itself a complex computer, a memory system, and a check-out device. It performs 6 major functions:

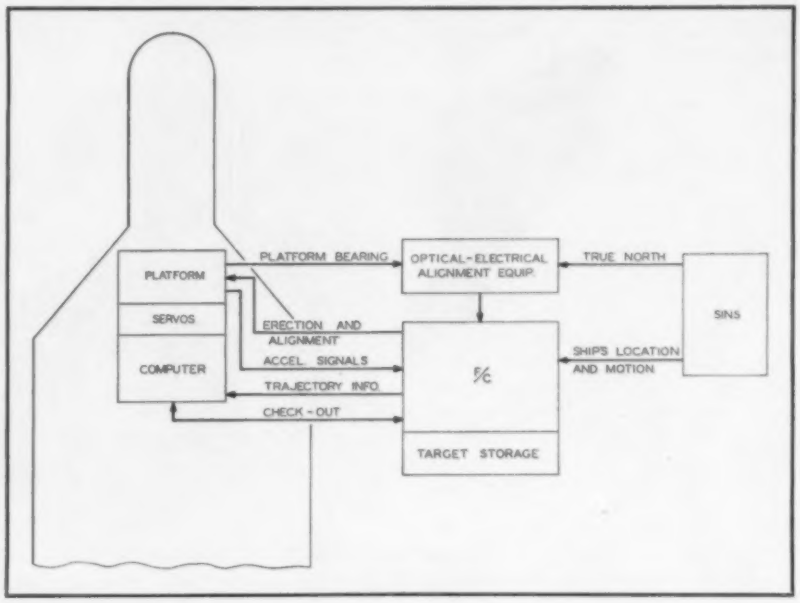
(1) Calculates geo-ballistic trajectories from target information stored within its memory and all the elements of launch point information supplied by the SINS.

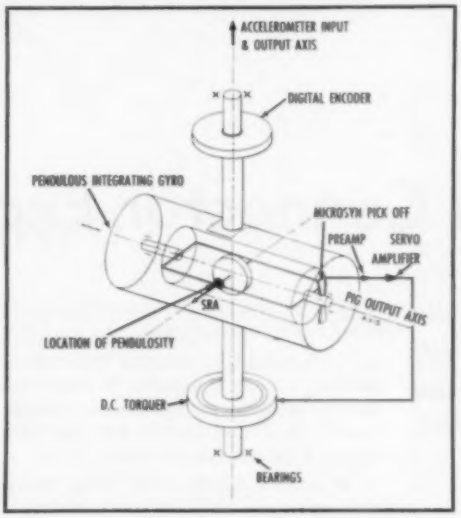
(2) Factors in the PIGA scale factor variations.

(3) Transmits trajectory coefficients and final velocity information to the missile computer.

(4) Computes accelerations at the

(Continued on page 53)

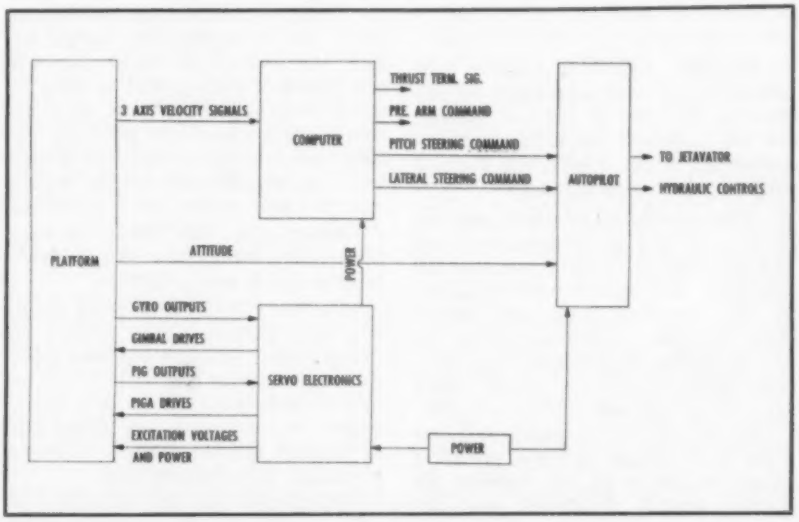


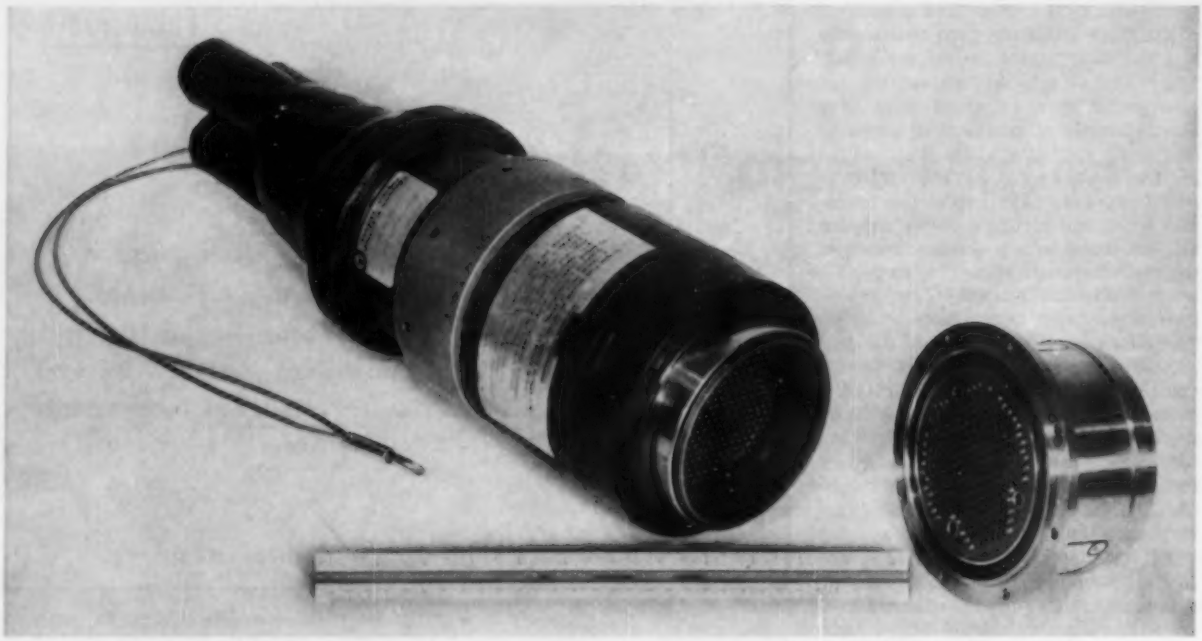


ABOVE: *Pre-launch information flow between Polaris guidance and the submarine support equipment is shown in this highly simplified block diagram.*

LEFT: *PIGA—Pendulous Integrating Gyro Accelerometer—typical of the type used in the Polaris inertial guidance platform.*

BELOW: *Major subsystems of the missile-borne inertial guidance and control systems.*





TANG MARK III is latest in Cannon Electric series developed in company-funded two-year project.

support equipment

Umbilical Connector Exceeds Demands of

Cannon Electric reports its Tang Mark III, with rugged and versatile collet-type lock, has passed 60-g test, taken huge acceleration

PHOENIX, ARIZ.—A radically new umbilical connector developed by the Phoenix Division of Cannon Electric Co. has surpassed the performance requirements of the Air Force's *Titan II* program, the company reports.

Most significant of these requirements is a 60-g endurance-type vibration test, applied to make sure that the connector will operate while subjected to the acoustical noise and sympathetic vibration conditions typical of silo launching installations. The Cannon device—designated "Tang Mark III"—passed the test on Dec. 15, 1960.

In addition, the company says, the Tang Mark III and its cable, providing signal and power circuits between the ground control equipment and the missile, has withstood acceleration levels never before encountered.

Comprehensive analysis and experimentation made it possible to overcome these mechanical resonances and fatigue conditions. The connector was carefully designed for maximum reliability.

• **A new family**—The Tang Mark III is third in a series of new connectors for umbilical and interstage applications.

The series combines established connector principles with new design features and concepts. It was developed in recognition of the fact that as space research and national defense programs demand larger and more powerful missiles, missile manufacturers will demand more reliable operation—under increasingly stringent environmental conditions.

Anticipating this trend, Cannon Electric Co. inaugurated its own development program two years ago.

The heart of the Tang Mark family is a new collet-type lock dubbed the "Tang Lock." This unit has been incorporated in various central lock and peripheral lock combinations. It is readily adapted to various releasing means such as manual lanyard, electric solenoid, pneumatic and explosive squib.

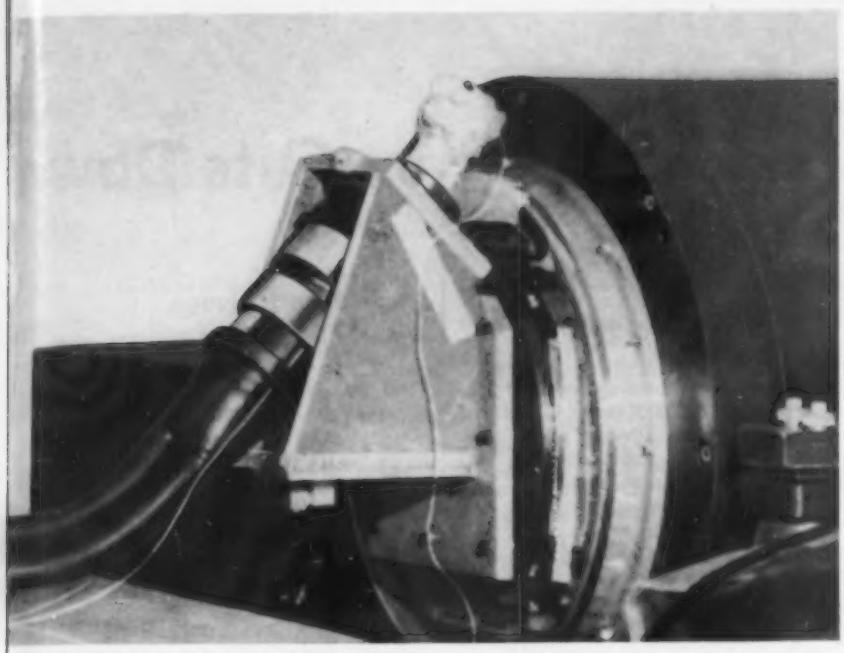
The flexible and efficient locking device will hold a plug and receptacle together in their mated conditions with thousands of pounds of force, and yet effect instant electrical separation and ejection with the application of a low specified force. For example, one design with a mating force of 6000 lbs. is released by a force of only 25 lbs.

• **60-g vibration problem solved**—Development of the "Tang Lock" is said to be a step forward much needed by the connector industry. This claim is supported by a discussion of some of the unique problems confronted in successful fulfillment of The Martin Co.'s vibration requirement for the *Titan II*.

The Martin sinewave vibration test required a 15-minute sweep from 5 cps to 2000 cps to 5 cps in each of three mutually perpendicular axes. During this test, a sweep rate of approximately one octave per minute was maintained; a constant excursion of 0.25 in. double amplitude was held between 5 and 66 cps and constant acceleration of 60 g's was held between 66 and 2000 cps.

An umbilical cable weighing 600 lbs. was terminated to the plug. This mass, combined with that of the 18-lb. plug, was supported by the receptacle—weighing only 4 lbs.

So severe was this test that neoprene-



UMBILICAL CONNECTOR, here undergoing test, is mated to Titan II at angle of approximately 45°.

# of Titan II Program

molded rubber in the proximity smoked from the generated frictional heat. Despite the combined high temperature and vibration, all electrical circuits maintained electrical continuity and passed Martin specifications by an easy margin of 5 to 1.

In addition to the sinusoidal endurance test, a resonant frequency survey was required. This consisted of a sweep through each of the three mutually perpendicular axes at 0.4 in. double amplitude from 5 to 12 cps and 10 g's peak from 12 to 2000 cps, during which time resonant frequencies were recorded. This was followed by a 35-g dwell for three minutes at each of the detected resonant frequencies.

Most outstanding result of this test was that the Tang Mark III had no significant resonances. The largest amplification factor recorded was 1.5.

Many other factors influenced solution of the vibration problem. One of the most meaningful was the fuel immersion requirement.

The *Titan II* uses a liquid fuel—Aerozine 50—and an oxidizer—Nitrogen Tetroxide, both of which are highly corrosive. Materials had to be selected carefully for greatest corrosion resistance. Unfortunately, the few usable materials are not optimum for structural purposes, and it was necessary to design around this deficiency.

• **Salient features**—The Tang Mark III would not have been possible without detailed study of future ICBM requirements and careful selection of development objectives. The product itself evolved out of a single, closely controlled project for *Titan II*, and can best be described by an account of its more salient features.

Operation of the unit is simple. Engagement is achieved by rotating a coupling ring on the plug body; a standard strap wrench is the only required tool. Disengagement is manual, effected by applying 150 lbs. force to the lanyard.

Fundamental to the connector design is its two-stage lock-release operation. In ejecting from the receptacle, the plug retracts all electrical connections before breaking a seal and mechanically disengaging. This prevents cocking or jamming during during release and excludes explosive mixtures from the circuit-breaking area.

The static strength of the Tang Mark III is 40 tons, which represents a structural safety factor of 10 when compared with peak dynamic forces. The peripheral-type lock is evenly distributed around the circumference of the connector, insuring optimum symmetry and mechanical stability.

Dynamics is a critical consideration with umbilical connectors because of their "series" relationship within the missile-ground control complex.

The environment of such umbilicals is greatly influenced by the missile engine, which is started and brought to full thrust before the umbilical disconnects. When the launch is made from an underground silo, this environment becomes even more hostile.

Having ten structural members and two basic moving parts, the Tang Mark III has employed three techniques to insure positive electrical continuity during engagement and to prevent prerelease (ejection of the plug before deliberate force has been applied to the release lanyard).

The first technique involves resonance compensation, wherein resonant frequencies are eliminated or self-compensated. This calls for control of the rigidity of structural members and resonance contributing parts.

The second technique utilizes vibration damping; even the individual parts are afforded this luxury. These resonances not eliminated by basic designs are either reduced in magnitude or changed to a frequency where their effect is less deleterious. Throughout the Tang Mark III, resilient materials are used in various ways to absorb energy.

The third technique uses a system of interlocks guaranteeing that the high mass of various parts cannot cause prerelease. The connector only releases when a steady force is applied directly by the lanyard. Thus, the forces developed in vibration, although extreme in magnitude, are incapable of effecting release.

Utilization of these three methods has resulted in a design that the company says is mechanically simple and offers a new high standard of reliabiliy.

The Phoenix Division of Cannon Electric Co. has been awarded its first order for the new connector by The Martin Co., marking the beginning of a new era for the connector industry. ⌗

Big Buy by Martin

The Martin Co. will use four Tang Mark III umbilical connectors per Titan II, with each umbilical containing 228 connector pins. The connector mates with the missile at an angle of approximately 45 degrees. Cannon Electric Co. says the umbilical connector could cost as much as $2500, depending on various production circumstances. The Tang Mark III passed all its environmental tests in December. Cannon believes it is the only connector in the industry to withstand a 60-g vibration factor.

Propellant Loading System Cuts Down Fu

Trans-Sonics' Equibar, built around pair of glass discs, is example of differential pressure gage type

by John F. Judge

ONE OF THE KEYS to optimum vehicle performance in current and future liquid rockets is accurate control of propellant loading—and in-flight propellant utilization.

Since most of the take-off weight of large liquid systems is propellant, the value of instrumentation which avoids the burden of an unusable percentage of fuel is obvious.

Upwards of 10,000 gallons of fuel and oxidizers are pumped aboard large vehicles in a very few minutes and to an accuracy of about 0.2%. The physical and chemical properties of the fluids compound the problem. And the necessity to hold a missile in stand-by condition for some time adds the requirement of an automatic topping system.

One propellant loading system currently used in a large development program is the Equibar, developed by Trans-Sonics, Inc., Burlington, Mass. The Equibar system is of the differential pressure gage type.

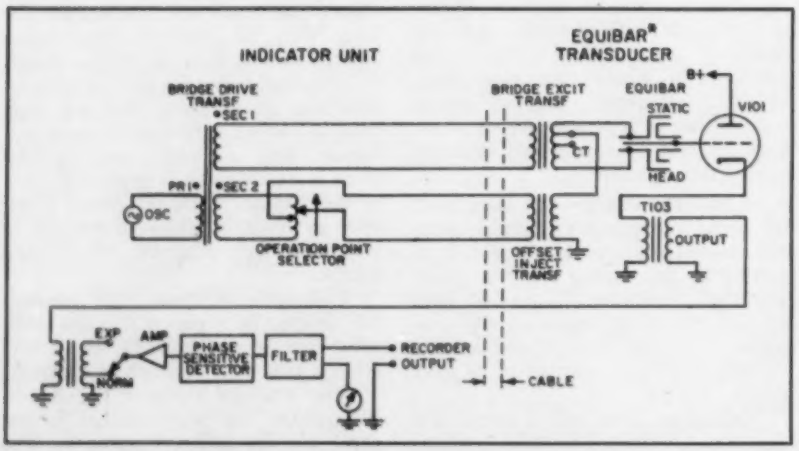
The loading system will indicate when a tank has been loaded to a preset value of a propellant mass. Mass values, which may range from 50-100% of actual tank capacity, may be remotely set into the system.

Indication is made continuously as a percentage of the preset mass value. During the initial loading operation, the system will indicate between 0-110% of the preset value.

The system has a d-c output, the value and polarity of which is proportional to the difference between the actual and preset loading value. The output may be used either for recording or to actuate a pump, valve or other control element.

• **Vital component**—The essence of the Equibar is a pair of similar glass discs, each with a shallow spherical cavity. The two discs in juxtaposition are separated by a metal membrane. A metal coating on the surface of each cavity provides an electrode. The two electrodes and the membrane comprise an electrostatic potentiometer.

Electrical output is obtained by using the potentiometer as half of a bridge, the other half being either a resistive potentiometer or an appropriately tapped transformer winding. Depending on the application, the frequency of the excitation signal applied to the bridge may be a few hundred or a few thousand cycles. The reference spring is the metal membrane held under large radial tension. Deflection of the membrane is approximately linearly proportional to the differential pressure.



SIMPLIFIED SCHEMATIC of the Equibar propellant loading system. Power supply consists of 115v, 400 cps, single phase to control panel for the entire system.

Tension in the membrane is approximately independent of pressure. Geometry, not strain, establishes an equilibrium position corresponding to an applied pressure. Thus, hysteresis proportional to change in strain is reduced to a negligible value. Instrument designs have been made for full-scale pressure ranges from 0.5 to 15 psi—covering the whole range of differential pressures which obtain for current propellants and tank sizes.

Each Equibar system consists of two differential pressure transducers and one control panel. The transducers are mounted directly in the vehicle while the panel can be located as far as 1500 ft. distant. Both fuel and oxidizer may be loaded simultaneously under the control of the system.

• **General systems**—R. L. Blanchard, A. E. Sherburne of Trans-Sonics and R. E. Scott, consultant, described instrumentation for loading and inflight utilization to the recent National Telemetering Conference.

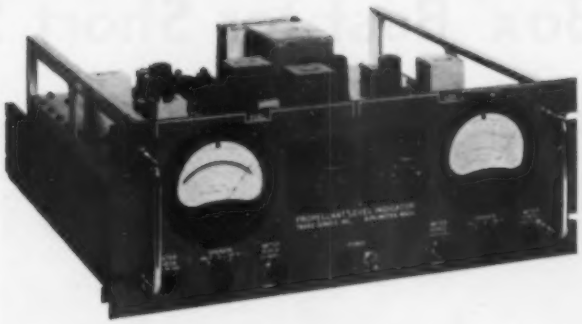
There are several different approaches to the propellant loading problem—volume and density, differential pressure and differential capacitance.

The volume and density method is simply the determination of mass from the product of volume and average density. The procedure provides for loading to a fixed mass or to small variations from a fixed mass of propellant. Accurate level sensors are required and are readily available.

Volume calibration of the tanks, temperature measurement or control of room temperature propellants, and temperature measurement or equilibrium pressure of cryogenic propellants are necessary. A ground-based flow meter for the incremental correction is also necessary, but the accuracy requirements for this flow measurement are not severe.

The measurement of differential pressure is the most direct means for determining total propellant mass. The method requires volume calibration of the tanks, and a differential pressure gauge accurate to about 0.1% and otherwise suitable for the application is

wn Fuel Burden



OPERATIONAL system consists of control panel and two transducers, one of which is pictured at right.

needed for effective measurement.

Provisions must be made to keep the liquid out of the pressure tap lines to avoid false pressures due to acceleration or pressure head of such liquid. A small flow of helium gas has been used successfully to continuously purge the lines.

The helium bubbling into the liquid propellant causes pressure fluctuations which are made relatively high in frequency by using a sufficiently high helium flow rate. The resulting fluctuations in the electrical signal are removed by the low-pass filter characteristics of the system.

The temperature differences may be handled automatically for non-temperature controlled fuels such as RP-1 and may be fixed for a cryogen. The density problem is largely accounted for in the method. The differential pressure method is especially suited to the loading problem for either a fixed or variable mass and where both propellants are cryogenic.

Incremental corrections for factors anticipated in a particular flight program are easily incorporated into the system, as is stand-by topping control, since the instrumentation provides a continuous analogue measurement.

• **Differential capacitance**—The difference between the dielectric constants of the liquid and gas phases of a propellant leads to a method for continuous analogue measurement of either volume or mass. A capacitor electrode structure extends the full length of the tank.

Below the surface of the liquid, the space between electrodes is filled with the liquid; above that level it consists of gas. By comparing the resultant capacitance with that of a completely submerged capacitor, the height of the fluid in the tank can be measured.

The system can be developed to measure mass in either of two ways. The temperature dependence of density can be used along with temperature transducers in a manner similar to the volume and density method. Or the relationship between dielectric constant and density can be exploited.

The technique hangs on the ability to measure capacitance to great accuracy and, considering the problems encountered in missile installation, cabling etc., this is not accomplished without thorough engineering.

The method has the advantage that it is a continuous system free from moving parts and the geometry of the tank is accounted for in the geometry of the sensor. But the achievement of high accuracy presents a difficult engineering problem.

• **Flying meters**—The Trans-Sonics experts then considered the in-flight closed loop control problem. The purpose of such a system is to permit the vehicle to carry a larger payload or achieve a higher velocity with the same payload.

Without a propellant utilization system, there is some uncertainty in the propellant burning rate and in the mixture ratio. The rocket must be designed to perform its mission in spite of this.

But the addition of such a system represents additional weight. Thus its effect in decreasing the amount of unused propellant must more than compensate for the added weight.

The scientists compared the final velocities of a group of rockets without utilization systems to a similar group with such systems. It turned out that some of the rockets without the system outperformed those with it. This is because the value preassigned to the amount of unused propellant was higher than the actual figure.

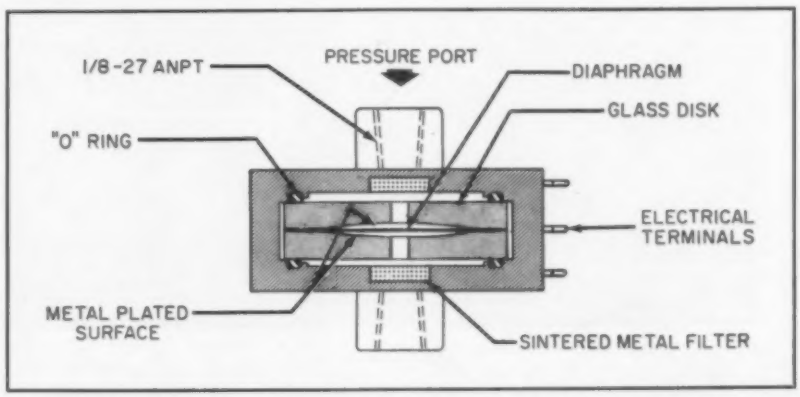
But the comparison also showed that the spread in final velocities is much smaller for the controlled rockets. The effect of the system is to decrease the tolerance on final velocity—thus allowing the use of an increased payload in a corresponding amount.

In-flight utilization system can be either continuous or discrete point systems; both are capable of high performance. The design of an in-flight system is similar to the loading systems. The major difference is that the absolute quantity of propellant is of primary interest in the loading system, while it is only of secondary importance in the utilization system.

The in-flight system has the primary purpose of causing a minimum of residual propellant at shutdown, with the restriction that the mixture ratio must not vary beyond certain limits.

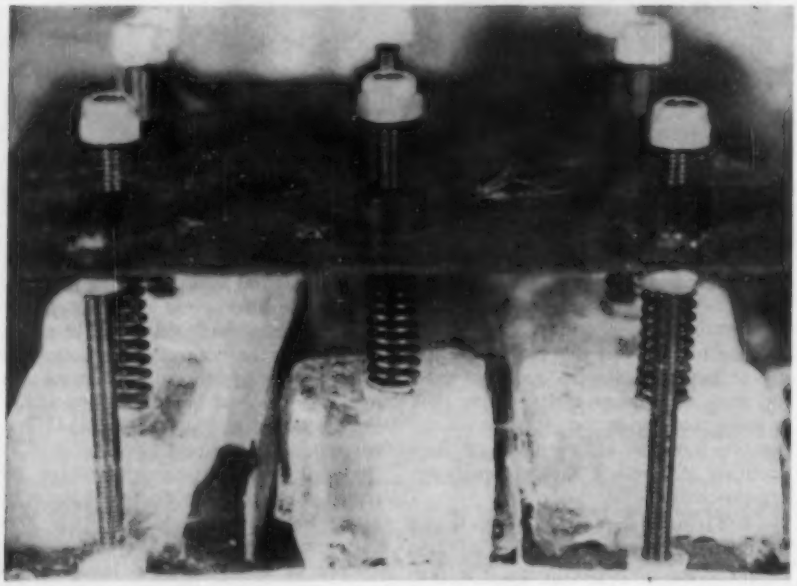
The Trans-Sonics experts conclude that differential pressure, point level sensors temperature measurements, fluid calibration and differential capacitance are the most suitable techniques for propellant loading where one or more of the propellants is cryogenic.

In-flight utilization control promises significant advantages but also presents a complex system problem. Only one missile has used such a system to date. ¤

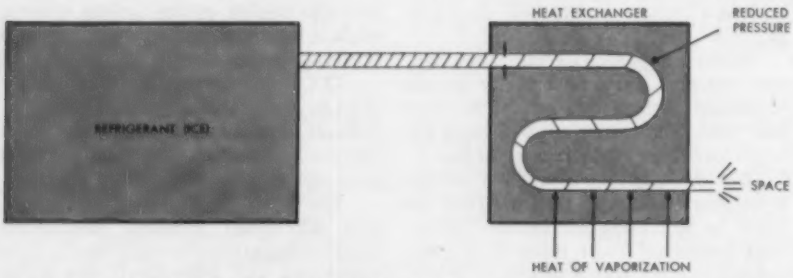


PRESSURE TRANSDUCER in system has already been used in experimental manned rocket aircraft as pitch and yaw control element. Diagram outlines operation.

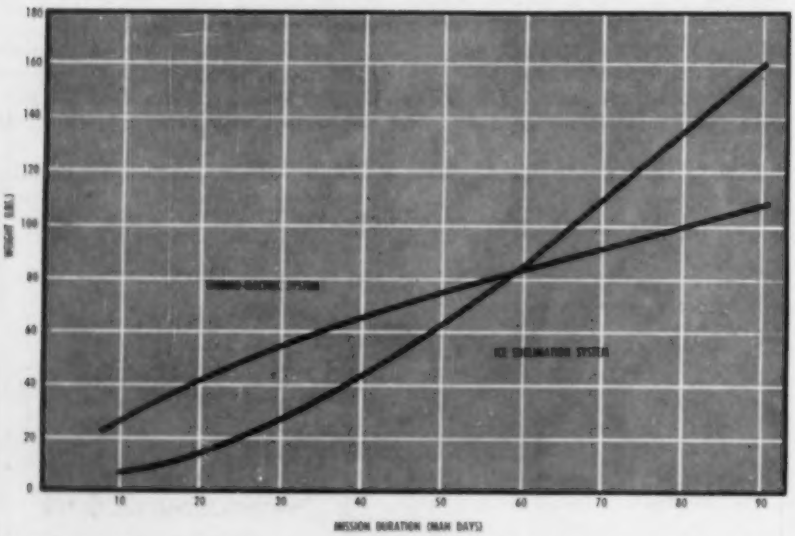
'Ice Box' Best for Short Space Trips



CHEAPEST SPACE REFRIGERATOR, sublimated ice cubes do well in lab tests.



GENERAL ELECTRIC CONCEPT is simple. Space vacuum obviates power source.



EXPENDABLE NATURE of system makes it feasible for only about 20 man-days, during which it compares very favorably with thermo-electric refrigeration. GE figures base weight for food and containers (20 days) in both systems to be about 100 lbs.

GE finds system converting plain ice into vapor may be simplest and most efficient refrigeration method

PHILADELPHIA—In a time of sophisticated Space Age engineering, technical breakthroughs and weird new devices, one company has come up with a refreshing old concept.

General Electric, long experienced in the appliance field, was given the task of developing some new refrigerating techniques for space vehicles under a $50,000 contract with Aeronautical Systems Division, AFSC (then ARDC).

GE's long experience in refrigeration would lead one to expect something rather advanced. Not so, says GE's Missile and Space Vehicle Department. In fact, for trips of about two weeks, the best way to keep food from spoiling probably is to carry along a cake of ice!

But GE's ice-box will have little resemblance to its predecessors except in componentry. While grandma's ice-box had a capability only of the relatively low heat of fusion (144 BTU's/lb.), GE's Space Age refrigerator has a heat absorption capability of 1220 BTU's per lb. of ice.

In the GE concept, the ice is converted directly into vapor rather than water by keeping it under a pressure no greater than .020 psi. In flight, the space vacuum would be used. This sublimation not only makes it a more efficient refrigerant, it eliminates the problem of liquid-vapor separation in the absence of gravity.

Laboratory tests prove out the idea. As shown in the diagram, the process is extremely simple. Ice cubes were used during testing to provide large surface areas and short thermal paths. Under pressure, the ice cubes were barely affected after hours of use.

As shown in the bottom chart, ice would be impractical for a trip of longer than about 20 man-days. Under Project *FROST*, GE has also studied various methods of keeping food for trips of several months and several years.

"A thermo-electric refrigeration system appears to be too costly in terms of power required," says Sid Halpert, *FROST's* project engineer. The system which affords the greatest promise for long journeys, he says, is a direct radiation system using space as a heat sink. This part of the program is still under evaluation. ⌗

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'Exotic' Communications of Small Use

Martin engineer finds that laser and deflected sunlight are only approaches in exotic region which appear to have practical value—even practical methods seem sure to be restricted to visible light

CHICAGO—The laser and deflected sunlight may hold the only practical potential in the way of "exotic" communications.

This is the finding of a Martin Co. engineer, L. R. Bittman, in a paper presented to GlobeCom V during the National Telemetering Conference.

Bittman's study was prompted by the mounting problem of spectrum-crowding of conventional radio-frequency communication and the coming need for communications ranges of astronomical distances in space exploration.

Areas considered in the study included ultra-microwave, infrared, visible light, ultraviolet, X-ray and gamma rays. The use of deflected sunlight, elementary particles, and even mail rockets was also studied.

Bittman said the exotic region—so named because conventional methods of radiation generation do not apply—begins at an arbitrary boundary of about 60 gigacycles (kmc). His evaluation showed that very few of the exotic methods studied would be practical. Quantum energy considerations would make them undesirable for communication purposes even if such methods were to be developed.

Areas studied and conclusions reached by the Martin study:

• **Ultramicrowave**—A fundamental breakthrough in generation techniques is needed to make this region useful. There is no practical method for generation of radiation in the 300-3000 gc range in excess of one milliwatt.

• **Infrared**—The development of infrared lasers may provide a method for obtaining useful amounts of coherent radiation. Conventional methods of generating IR radiation, however, involve a degree of incoherence which make it unsuitable for communications. Filtering for monochromatism and attempting to increase power densities—which requires an increase in temperature and shifts the power peak frequency—both reduce power efficiencies to impractically low values.

• **Visible light**—Recent laser developments point to a future visible-light communication system. Radiation is coherent and power densities extremely high. Estimated intensities per unit wavelength are one million times that of the sun.

• **Ultraviolet** — Several techniques have been recently proposed for use of UV in space communications. One method, using exploded wire, produces a power density peak in the UV region and looks feasible for transmission over astronomical distances. Power conversion efficiency is quite low, however. *(Ed. note: Westinghouse scientists recently developed a UV generator they say is capable of transmission ranges of 50 million miles with a radiated power of one watt.)*

• **X-ray and gamma-ray**—X-radiation is largely incoherent, consisting of band spectra with superimposed monochromatic peaks. The radiation cannot be focused and power conversion efficiency is very low.

Gamma radiation, although proposed as a direct means of communication, appears to offer more potential as an energy source to power more efficient radio generators.

• **Deflected sunlight**—An elaborate heliograph, even though of limited range and channel capacity, would provide a practical communication method. The sun's light energy—although a noisy, incoherent source—is free, and total radiation is high. Energy intensity is very low; a large portion of the visible spectrum would be required for long-range transmission.

• **Particle systems**—Since free space would produce negligible scattering of a beam of particles, such beams, modulated to carry information, appear attractive for many reasons. Charged particles, however, are affected by magnetic fields; such a system would not be practical in the vicinity of earth or any other planet with an appreciable magnetic field. Also, calculations show that the maximum attainable range would be in the order of tens of thousands of miles, rather than the millions of miles required for a practical deep space communication system.

As for a neutral atom particle system, only very-low-power efficiencies can be foreseen. In addition, there remains the question of what happens to the beam when the neutral atoms are photoionized by the sun's Lyman-alpha radiation.

The only real justification for exotic system development, according to Bittman, is the need for a communications link from outer space back to earth. Already overcrowded terrestrial links cannot tolerate the additional interference contributed by space-to-earth radio transmissions.

The radio-spectrum for space-space communications, Bittman says, has no allocation problems—and is not likely to have in the near future. Therefore, conventional methods will suffice.

The argument for exotic methods on the basis of narrower beamwidths—and resulting greater antenna gains—was torn down by Bittman. He said that beyond the submillimeter band it would be impossible to aim such narrow beams with any probability of their detection by a receiving antenna. In the visible light region, the tracking problem would be so severe that the beam would have to be enlarged to secure a communications link, thereby losing any advantage gained.

Conclusions reached by the Martin study showed that even if a practical exotic method were to be developed, it almost certainly would be restricted to operation in the visible light region—since this is the only portion of the spectrum possessing a transparent window in the earth's atmosphere. Consequently, since the need exists only for a system capable of operating within or through the atmosphere, only the laser and deflected sunlight offer promise as communications links. ⌗

Ignorant Test Techniques Deplored

LOS ANGELES—A leading industry executive has charged there is an "appalling" lack of knowledge of how nondestructive testing techniques can aid the U.S. missile and space vehicle program—and that this ignorance extends through every echelon of government and industry.

Kermit A. Skeie, Director of the Materials Testing Laboratories of Magnaflux Corporation, said agencies responsible for hardware design can call out exact testing techniques to assure ultimate performance, but too often require tests which will meet an arbitrary specification without assuring that the component will ever fulfill its purpose.

At a recent meeting on non-destructive testing, he said "when military specifications allow a manufacturer will use the cheapest, simplest—and often least effective—test method available. This is intended to satisfy military specification requirements, but gives no indication of the component's soundness or ability to do its job. The aim, of course, is to save time and money . . . both of which are lost ultimately anyway."

Richard P. Turner, Western Regional Manager for Magnaflux, advocated that specifications place greater emphasis on nondestructive testing, with sufficient leeway for choosing the best test method, regardless of its type.

"We can't test the materials and components of 1961 with the test attitudes of 1941," he said, "and many companies are trying to do just that. They have a World-War-Two-type inspector at the end of a line who sees that the part is within its dimensional tolerances; then they X-ray it . . . maybe . . . and presume that nothing else can be done."

"Despite the qualifications of most engineers within their own fields," he continued, "it is amazing how many seem to feel that nothing escapes an X-ray and that no other test method can possible compare in effectiveness. We once had a minor component design come to our attention that was to be tested by exposure to 22 X-rays from different angles. A component like this often doesn't need 22 X-rays . . . it needs redesign."

• **Few and unconsulted**—Skeie said he knows of no college or university presently teaching test engineering. Most test engineers, he said, are converts from other engineering areas.

Our present system, he said, rarely incorporates test engineers in basic hardware design phases. A prime question, Skeie argued, should always be: "Can we adequately test this thing to be sure it will work?" But since fully qualified test engineers are seldom invited at this stage, the question isn't asked. Later in the program, major reworking is needed because the part won't work.

He recalled one unnamed missile program in which engineers designed a large tank, to be fitted with a pipe at one end. The final design called for a hole to be drilled, the pipe (unthreaded) to be jammed into the hole and brazed about the surface of the junction.

"They couldn't have designed a better built-in circular crack . . . guaranteed to fail," Skeie commented. The braze passed inspections called for by MIL specs, he added, but didn't perform. "The tank caused a major upset of the missile program's schedule, and the surprising thing is not that the things failed, but that any worked at all."

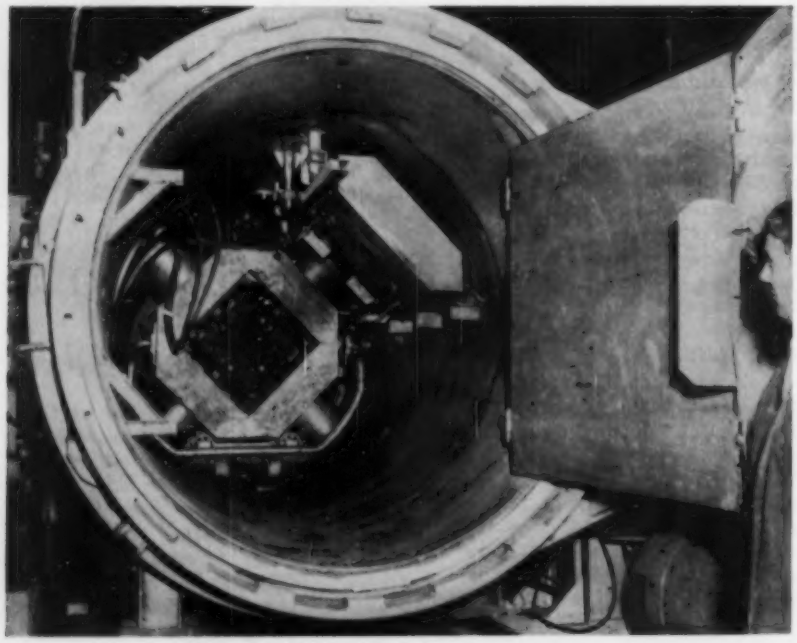
Asked for an estimate of how many fully qualified test engineers are now in industry, Turner placed the figure in the dozens.

Specific recommendations made by the Magnaflux executives were:

1. Introduce adequate testing considerations as early in the design stage as possible, giving more thought to filling missions rather than filling specifications not intended to cover the problem at hand.

2. Allow greater leeway in specifications calling for tests. The amount of time presently required to change specifications sometimes prevents an effective test program being carried out because it fails to fill a spec written several years previously. Test specifications should stress the end use of the item.

3. Provisions should be made for a long-range increase in the number of qualified test personnel, including university courses and greater in-plant utilization of contributions to be made by test engineers. ⌗



Testing by Firing

ENVIRONMENTAL TARGET CHAMBER, built by Tenney Engineering Company, will be used to test potential space materials. The 6x18 ft. compartment, built for the Air Force's Arnold Engineering Center, at Tullahoma, Tenn., can simulate air pressure at 75 miles altitude, apply a heat source up to 1500° in two hours, and fire projectiles at undisclosed velocities through an evacuated 10-in. tube extending 30 ft. out of the chamber to a gun arrangement.

Is Defense Advertising Necessary?

There has been a lot of talk lately about the cost of the advertising done by defense contractors. One prominent Senator recently said he was greatly disturbed over heavy defense advertising expenditures. He pegged the cost "to the taxpayer" at $500 million.

This figure is many, many times the actual total of defense advertising expenditures and only a fraction of that total is recoverable. The Senator's facts are wrong; but, even more disturbing, it appears that he doesn't understand the purpose and function of sound advertising. He considers this money down the drain and thinks it should not have been spent.

There are other instances demonstrating a growing wave of anti-advertising sentiment in high government places. They indicate a lack of understanding and represent a threat both to freedom of the press and success of the Nation's defense goals.

We publish specialized business magazines and reference books. Several of these are defense oriented. They perform communications functions essential to our national goals . . . more essential now than ever before because of the complexity of today's technological and political challenges. There are other excellent magazines having the same or similar purposes. We're delighted—because competition is healthy and because there is more to be done than can be handled by any one of us.

Virtually all publications are financed, by and large, by advertising. This is healthy, too; but it is not the primary reason for defense advertising.

We believe that advertising is an effective and necessary tool for the defense contractor. The objectives of defense advertising are many: some of them obvious, others more subtle.

Sales is one obvious objective. It can be demonstrated that advertising, for some defense products, has led directly to sales. In other instances, selling is a long, complex process, where features of current products may not be as important as company reputation. In both cases, the government wants competition for defense contracts—by use of a competitive bidding system, it gets better products for less money. How is a company to compete if it is not allowed the use of sales tools—one of which is advertising?

Recruiting is another obvious objective. Will that engineer who is inspired to contribute to technological advancement in the missile/space age, for example, be interested in learning more about the kind of company he goes to work for? You bet he will, and more power to him.

The dissemination of technical information is a third, and perhaps the most important, objective. The exchange of such information is one of the biggest problems facing both government and industry. And what more effective, more economical means of disseminating necessary technical information exists than the business press? Mills Shepard, who performs readership studies on one of our publications, reports that advertisements are often read as avidly as the editorial pages. And Eastman Research, in a study released May 29, based on more than 100 surveys for 32 business-paper clients over a two-year period, reports that *70% of the readers interviewed read the advertising in these businesspapers on purpose.*

There are many other equally important objectives. Companies must raise capital in order to be able to do the jobs that need doing for defense. Good community and employee relations are considered necessary to a company's well-being. These and other objectives have been effectively achieved by defense contractors through advertising.

The defense industry is made up of numerous private companies facing the tremendous challenge of meeting, in cooperation with the government, our national technological goals. To meet this challenge, the companies must be strong and healthy. To deprive them of the use of effective and honest advertising is shortsighted and wrong.

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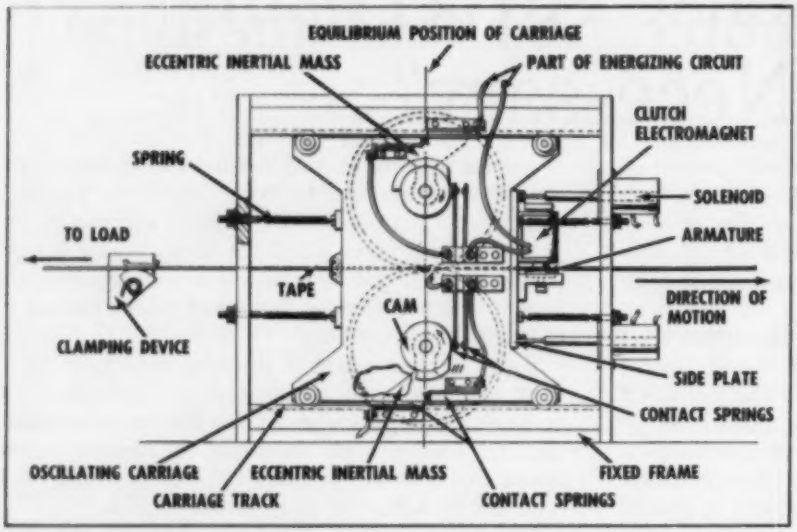
Doubtful View of Dean Space Drive

(Continued from page 25)



SYSTEM PATENTED by Dean for transforming rotary into unidirectional motion.

tween the load and its support was minimized by the use of rollers, the friction forces becoming less than an ounce.

Here are the results: "The load oscillates at the same frequency as the (carriage) but does not advance toward it. If the load support is slightly inclined from the horizontal, the load rolls downhill, the direction and rate of rolling being independent of whether or not the (carriage) is operating."

Rabinow maintains that the focus of interest should be on the carriage and not on the fixed frame—since the frame is, in effect, isolated from both load and carriage.

Consequently, he says, if the frictional forces of the load were smaller than the reverse spring forces, and if the positive and negative impulses were equal, the load would move backward due to the spring force and the net displacement would be zero.

Thus, the second test shows that the machine has no net unidirectional effect on an inertial load if the frictional load is small compared to the mass.

• **Operating criteria**—In another test, Rabinow modified the friction beneath the load by connecting a spring with variable tension between the load and a point behind it.

As a result of this test, it was concluded that "when the resultant of external spring load and internal spring bias is approximately equal to the static friction, the load moves backward during the negative impulse and hence oscillates instead of advancing."

In the last test, wire strain gages were mounted on the load arm. The resulting traces on an oscilloscope were force-time plots. The most important conclusion reached—in view of the current controversy—is that momentum was indeed conserved. Rabinow noted that the area under the positive spikes is equal to the area under the negative portion of the traces. "In other words," he says, "the positive and negative impulses applied to the load are equal."

In general, then, the load moves toward the carriage if:

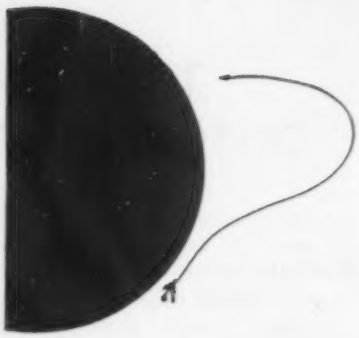
1. The peak force developed during the positive impulse—clutching of carriage to load—is greater than the load's static friction, and

2. If the opposing spring force developed during the remainder of the cycle is less than the static friction.

The phenomenon being exploited by Dean in his demonstration model is nicely illuminated by an example given by Rabinow. He envisions a man on roller skates trying to move a table. He can do it by using his own inertia and pushing in a series of jerks. He needs only to produce short pulses of forces greater than the value of static friction between the table and floor—and he can do this even though he's mounted on perfect wheels.

In fact, Rabinow observes, the portion of the floor on which he rolls could be suspended as a free pendulum to show that he has no reaction on the floor. He would reset himself for the next pulse merely by using the force of the static friction between the table and its base as his anchor.

On the other hand, if the load itself were mounted on perfect bearings, the man and the table would oscillate but neither would go anywhere. ⠿



SKYBOLT

This new USAF weapon now under development will combine the range and mobility of the jet bomber with the speed and the difficult-to-detect capabilities of the ballistic missile. Yet Skybolt's warhead-carrying re-entry vehicle must operate with the same reliability and accuracy of ground-launched re-entry vehicles.

Environmental conditions—The re-entry vehicle must withstand hour after hour of vibration and noise fatigue aboard its bomber "launching pad"—the USAF B-52 and the RAF Vulcan bomber. Its heat protection system must endure repeated thermal cycling from ground take-off temperature to −65° F at cruising altitudes. If launched, it could be exposed to re-entry temperatures of 7500° F.

Extended Life—Skybolt's re-entry vehicle must have a useful life of several years, through repeated storage, thermal cycling, and return to storage—all with a minimum amount of maintenance.

The Skybolt missile system is being developed from known and proven engineering principles, resulting in rapid program advancement at great saving to the American taxpayer. The Missile and Space Vehicle Department of General Electric's Defense Electronics Division is developing Skybolt's re-entry vehicle. 160-05

GENERAL ELECTRIC

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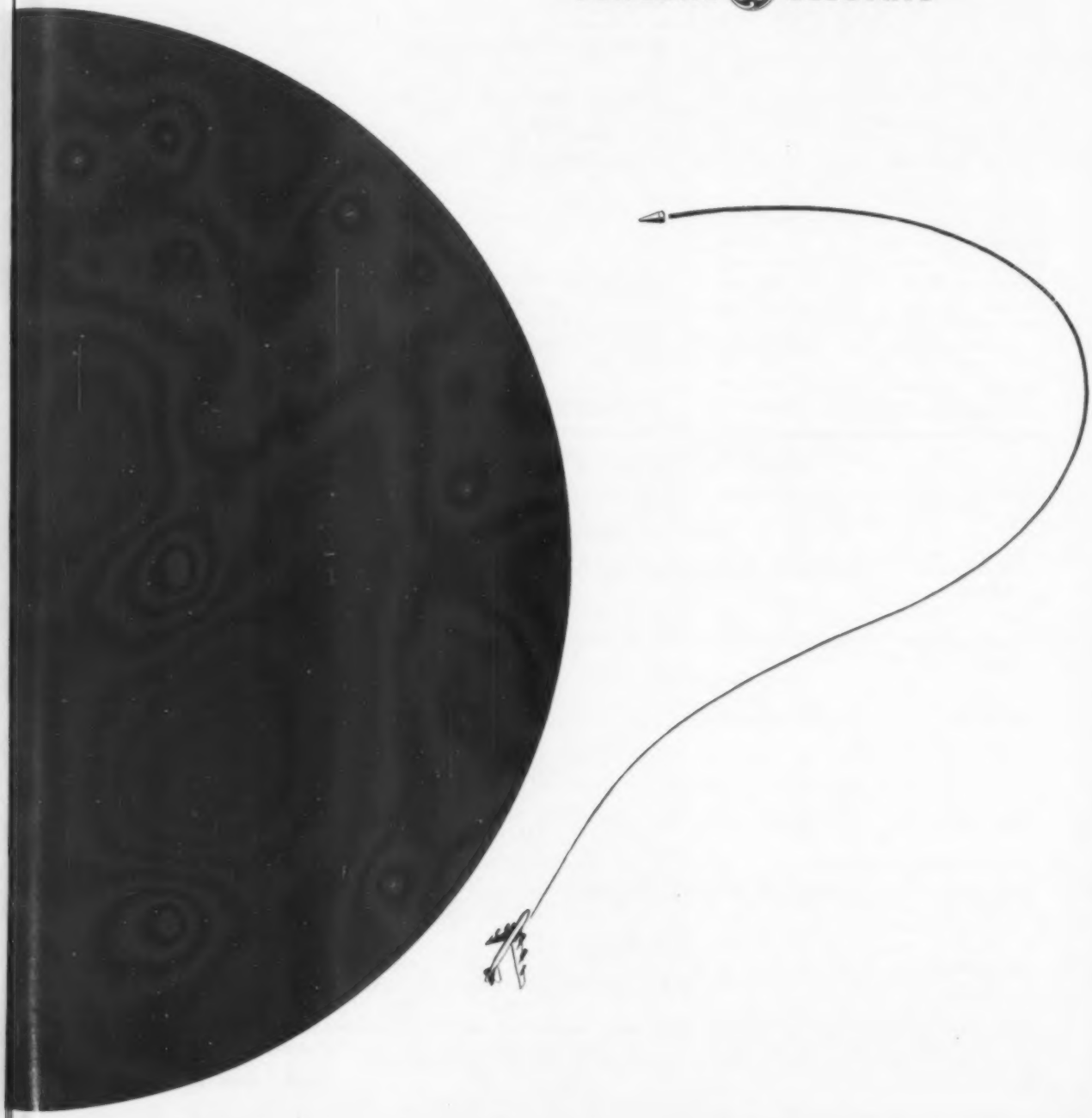
MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

SKYBOLT is being developed to add a new dimension to America's growing missile might. Launched from an airborne B-52, it is being designed to arc through space toward targets more than 1000 miles away. The re-entry vehicles for this advanced USAF missile are being developed by General Electric's Missile and Space Vehicle Department under contract to Douglas Aircraft Company, prime contractor for Skybolt.

GENERAL ELECTRIC



NASA Submits Overhauled Indemnification Legislation

A REVAMPED PROPOSAL allowing NASA to indemnify contractors against unusually hazardous risks in space contracts was given to the House Space Committee by the space agency last week.

The new version, designed to counter objections raised before the Senate Space Committee earlier (M/R, May 22, p. 45), would require firms to obtain all available commercial insurance before becoming eligible for Federal protection. NASA Administrator James E. Webb explained that in this way firms would be protected from ruin without making the agency an insurer where commercial coverage was "reasonably available."

The proposed section resembles the indemnification feature of the Atomic Energy Act which limits government liability to $500 million for any one nuclear catastrophe. Coverage would also extend to subcontractors.

As the agency would amend it, the bill (HR7115) also: (1) calls for remedies provided in state workmen compensation acts to be deducted in evaluating government liability; (2) permits Congress to pass on—through special appropriation—any damage claim exceeding $100,000 and (3) requires NASA to use the facilities and services of private insurance organizations to the maximum extent practical in administering the law. ¤

mergers & expansions

UNITED NUCLEAR CORPORATION, New York, has acquired the Nuclear Fuels Operation of Olin Mathieson Chemical Corp., the Nuclear Division of Mallinckrodt Chemical Works and the Nuclear Development Corp. of America, through exchange of stock.

GENERAL MILLS has consolidated all activities within the company involving electronics and allied fields, together with two wholly-owned subsidiaries, into the General Mills Electronics Group.

Major facilities will be in Minneapolis, Chicago, Los Angeles, Livingston, N.J., and Manchester, N.H. Personnel of the present Mechanical Division will form the nucleus of the new organization. The division's activities will be taken over by four specialized groups, each operating semi-autonomously as an Electronics Group member-organization.

There will be an Electronic and Mechanical Defense Products Department. Balloon and Aerospace Systems Department, Automatic Handling Equipment Department, and Research Department. Magnaflux Corp., Chicago, and The Daven Company, Livingston, N.J., are the subsidiaries completing the Electronics Group. Richard A. Wilson, corporate vice president, will direct overall operations of the Electronics Group, and will continue as chief executive of both Magnaflux and The Daven Company.

RADIO CORPORATION OF AMERICA has formed two new divisions in its Defense Electronic Products organization. The Major Defense Systems Division, Moorestown, N.J., will be managed by D. Brainerd Holmes, and the Aerospace Communications and Controls Division, Camden, N.J., and Burlington, Mass., by Irving Kessler, Division Vice President and General Manager. Arthur L. Malcarney, DEP Vice President, says of the new departments: "Adjusting to the volatile conditions of national defense requires an underlying philosophy of flexibility. Our changes will concentrate more effectively our capabilities and skills in major defense areas. . . ."

LORAL ELECTRONICS will acquire American Beryllium Company, Inc., and its subsidiary operations, U.S. Beryllium Corp. and Visioneering Corp. Loral's board of directors approved the action and said American Beryllium will operate as an independent, wholly owned subsidiary of Loral.

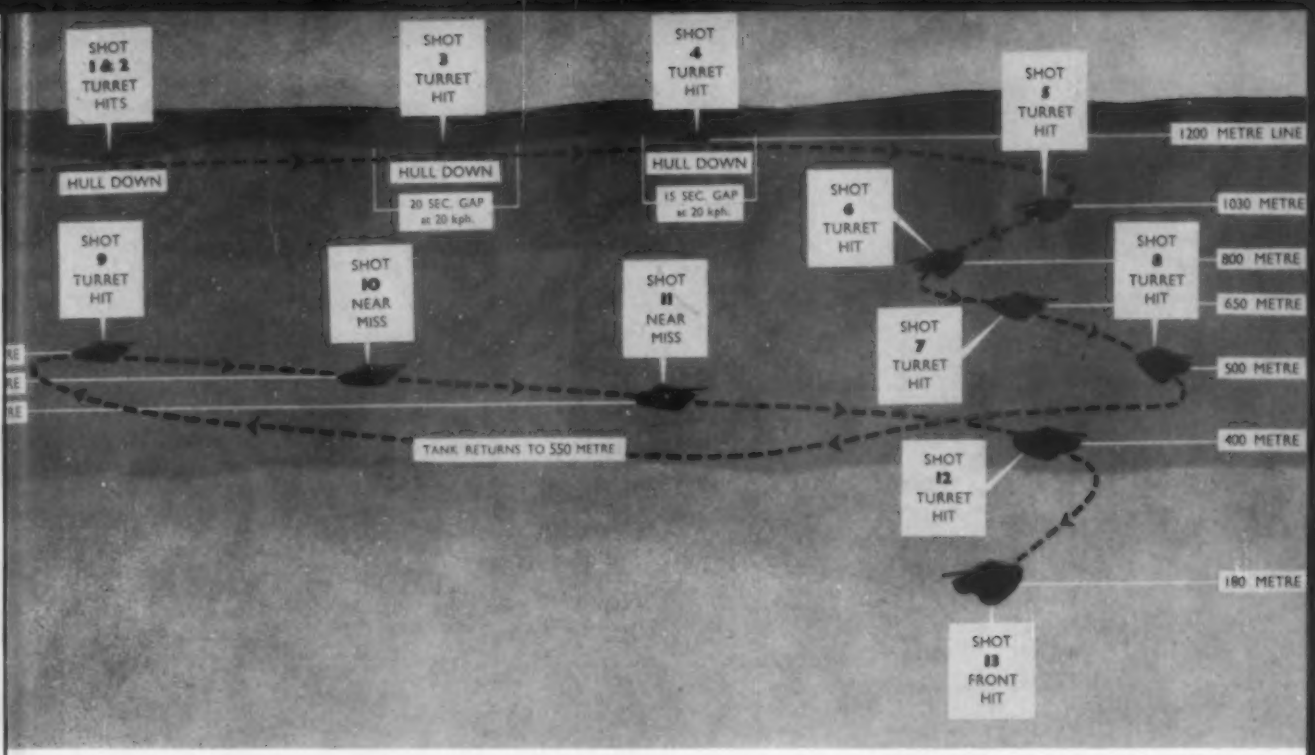
MOTOROLA SEMICONDUCTOR PRODUCTS INC. has opened a 315,000-sq.-ft. addition to its Phoenix manufacturing facility, more than doubling the plant's present size. The Company says its plant is now the second largest single semiconductor production facility in the U.S. It expects to add a "substantial number of additional employes" in the next few years. The addition cost some $4.8 million, to which will be added an estimated $2 million worth of manufacturing and research equipment.

THE BARDEN CORPORATION, Danbury, Conn., has announced formation of the Barden Research Precision Mechanisms Division to design, manufacture and market precision devices.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
California Eastern Aviation	3 mo. Mar. 31	$ 8,447,819	$ 8,073,999	$ 179,856 ($0.09 per share)	$ —244,431
General Instrument Corp.	Year, Feb. 28	70,644,123	66,895,542	3,424,891 ($1.41 per share)	2,655,652 ($1.23 per share)
Microdot Inc.	3 mo. Mar. 31	1,457,539	756,766	91,537 ($0.21 per share)	46,371 ($0.18 per share)
	6 mo. Mar. 31	2,497,875	1,525,741	164,292	113,681
Motec Industries Inc.	3 mo. Apr. 28	17,081,968	1,262,771	748,340 ($0.77 per share)	981,869 ($1.02 per share)
*Northrop Corp.	9 mo. Apr. 30	196,766,000	170,184,000	6,258,000 ($3.22 per share)	5,313,000 ($2.73 per share)
Atlantic Research Corp.	Year, Dec. 31	(1960) 13,513,889	(1959) 8,315,163	811,689 ($1.01 per share)	438,614 ($0.57 per share)

*Company says sales rise was helped by deliveries of Datica automatic electronic evaluation units for *Polaris* and on-schedule progress of *Skybolt* guidance system.



PATH OF TANK and launching position distances during Vigilant demonstration.

international

Vigilant Scores Kill at –200 Yds.

A Vickers-Armstrong Ltd. *Vigilant* infantry antitank missile recently hit a moving Patton M-46 tank less than 200 yards away—believed to be the shortest-range strike yet demonstrated by such a weapon.

The trials, which took place on a range "somewhere in Europe," were witnessed by senior British and Allied officers. The ranking officer termed the short-range hit "fantastic."

During the tests, the British Aircraft Corp. trials team was asked to engage a moving target as close in as 218 yards. Immediately accepting, the team directed the tank to a 300-meter line and told it to come in along a side road of the range. At what was later discovered to be 200 yds. range, the round was fired.

The 340-mph. *Vigilant* was whipped onto the sight-line in 100 yds., using the 6-g turning power of the weapon's steering flaps. The tank was struck on the lefthand track, just under the turret, while moving at 18 mph on a 10° crossing to the right.

The weapon was put through a series of other tests involving the tank. In one instance, the operator scored two clean hits on the turrent even though it was visible only for a 20-second and a 15-second period.

During the trials, the *Vigilant* ran up a score of 11 hits out of 13 attempts at ranges from 200 to 1300 yds. This includes firings by personnel with brief experience.

The driver of the tank, alerted by radio to each firing, had been able to see the rounds in flight. According to Vickers, experience has shown that a round can be seen if the driver is prealerted and concentrates on the direction of attack.

But it has also been shown that no maneuver, including stopping and backing, has been able to avoid a hit.

Company spokesmen say that the weapon offers a considerable savings in training and training costs. The average infantryman needs only a simulator course plus three or four live rounds to be a competent operator. Trainees have frequently hit six out of six moving targets on their first live firings. ⌗

ANTITANK MISSILE at moment of launch. Its accuracy stems from a twin-gyro autopilot which eliminates weaving flight characteristics of acceleration control.

COMING UP!

The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

The 5th annual issue of the Missile/Space Encyclopedia will be distributed to MISSILES AND ROCKETS' 32,500* paid subscribers—plus a bonus circulation of 7,500 for distribution to top military personnel and to U. S. service academies.

With a total distribution of more than 40,000,* M/R's July 17 Missile/Space Encyclopedia issue will thus reach virtually all of the people who direct the activities of the missile/space industry, with the most complete coverage-in-depth of key buying and specifying influences.

*Subject to audit.

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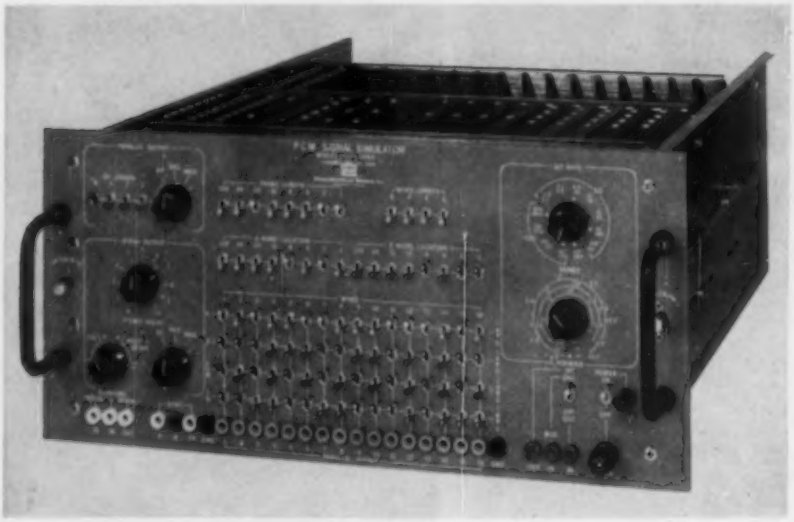


Signal Simulator for PCM

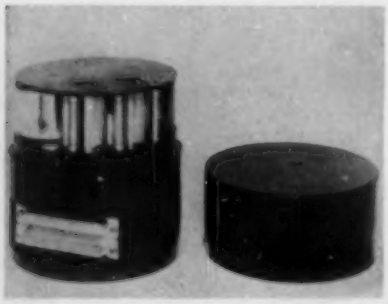
A signal simulator which provides PCM signals for checkout, calibration or evaluation of PCM telemetry equipment has been developed by Electro-Mechanical Research, Inc. Th. unit fills the need for a versatile digital instrument which can check out existing PCM equipment and equipment planned for future programs.

By means of front-panel controls, the bit rate may be set in the range of 50 bps to 200,000 bps; the frame length may be set in the range of 1 to 256 words; and word length may be chosen in the range of 1 to 16 bits. Provision is made for an external clock input. The data content of all words can be preselected by front-panel binary-coded switches permitting choice of any word-sunc code, parity code, or data code. The Model 208A provides both series and parallel outputs.

Circle No. 225 on Subscriber Service Card

Miniature Tape Recorder

A miniature magnetic tape recorder which simultaneously records data (1 to 14 channels, in line or interlaced) from tests conducted under severe environmental and extremely limited space conditions, is available from Aero Data Corp., Division of American Concertone, Inc. Model TR-1875 is available in speeds of 1.875, 3.75, 7.5 and 15 in. per second, with a capacity of 150 ft. of 1-mil Polyester Instrumentation tape providing up to 16 minutes recording. This is a small, lightweight, precision-built unit measuring 4¼ in. dia. and 4¾ in. long, weighing less than 3½ lb., complete with full load of tape. The wow and flutter under static conditions is less than 1%.



Circle No. 226 on Subscriber Service Card

Cryogenic Measuring System

A low-temperature cryogenic measuring system has been developed by Texas Instruments, Inc. This system includes a germanium thermometer and a special "servo/riter" potentiometric recorder. The germanium thermometer is available in three versions: calibrated, uncalibrated, and standardized. The thermometer (or cryometer) couples with the special "servo/riter" recorder resulting in a system which accurately obtains low-temperature measurements.

Circle No. 227 on Subscriber Service Card

Miniature DPDT Chopper

A line of unique low-noise DPDT miniature choppers for microvolt instrumentation applications is available from James Electronics Inc. Nine-pin plug-in and flange mount models are available. Frequency response is 1-500 cps at microvolt levels.

Circle No. 228 on Subscriber Service Card

Transient Suppressors

Relcoil Products Corp. is marketing a line of transient suppressors. The TR Series are encapsulated solid-state devices designed to protect electronic circuitry from damage caused by line transients and from transients caused by the switching of inductive current loads. These transients may vary from only a few volts to several thousand volts, and can vary from microseconds to many milliseconds in duration.

Circle No. 229 on Subscriber Service Card

DC Null Voltmeter

Outstanding stability and resolution with 1-millivolt end scale sensitivity, and a floating, high-impedance input are principal features of new Hewlett-Packard Model 413A DC Null Voltmeter. A d-c Null Voltmeter, having 13 zero-centered ranges, running from 1 millivolt to 1000 volts end scale is available from Hewlett Packard Co. High input impedance (10 megohms on the most sensitive range, 200 megohms on the 300 millivolt range and above)

makes this instrument especially valuable in resistance bridge measurements.

The input terminals are isolated from ground, allowing operation up to 500 volts dc or 130 volts ac from ground potential. Accuracy of the unit is within 2% of end scale. Drift and noise are virtually imperceptible.

Circle No. 230 on Subscriber Service Card

Feed-Thru Capacitor Line

Dearborn Electronic Laboratories, Inc. has introduced a line of "clear pass" feed-thru capacitors that are a subminiature-type feed-thru radio interference suppressor. Dimensions range from 0.312 in. O.D. x 5/8 in. long to

1 in. O.D. x 1-5/16 in. long. The components combine maximum insertion loss over a broad band of radio frequencies with minimum size and weight.

Dearborn engineering design of the threaded neck on the capacitors effectively eliminates inductance between noise source and output terminals. This design also minimizes contact resistance to chassis, thus obtaining near-optimum insertion loss.

Circle No. 231 on Subscriber Service Card

Plotting Instrument

Numerical control techniques and highly accurate shaft position encoders are employed in a point plotter developed for precision layout of templates, charts and other work requiring exact positioning and available from Datex Corp. The instrument employs two servo-driven carriages mounted on the X and Y rails of a basic Haag-Streit machine. Carriage positions are measured by two Datex CG-703 Geared Shaft Position Encoders having a resolution of 0.001 in. The extreme accuracy of the encoders permits carriage position determination to five significant figures over the entire 47-sq.-in. working area.

Circle No. 232 on Subscriber Service Card

Universal Template

A template for drawing pictures of bent-up sheet metal parts of all gauges from .020 thru .090, in any of the four quadrants and with bend radii from .03 to .25 is available from Barto Co. Drawings of sheet metal parts are made more quickly and more accurately with this template than is possible by the old-fashioned hand method of measuring the thickness with a scale and then trying to draw the inside bend radius and the outside bend radius with a circle template or compass .

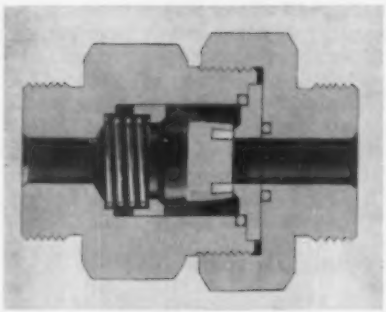
In addition to its use in drawing formed sheet metal parts, the Universal Template can be used as a gauge to indicate the thickness of flat sheet-metal parts.

Circle No. 233 on Subscriber Service Card

O-Seal Valve Ends

Combining the radical concepts of a soft-seated valve and O-ring fitted connections and unions, a CPV O-seal system which gives proven leakproof flexibility for handling liquids and gases at pressures to 6000 psi is available from the Combination Pump Valve Co. The heart of the O-seal valve is the resilient nylon disc which deforms and perfectly assumes the surface of metal seat, assuring positive valve shut-off.

Even the eroding effects of high-pressure, high-velocity gases do not affect bubble-tight valve closure at pressures in excess of the rated 6000 psi.



A Teflon thrust washer and O-ring stem seals eliminate the need for valve packings, a potential source of leakage and a constant maintenance headache.

Circle No. 234 on Subscriber Service Card

Phenolic Resins

Two phenolic resins developed to withstand exposure to high temperatures encountered by missiles and space vehicles are available from Reichhold Chemicals, Inc. One, designated Plyophen 23-017, is a phenolic silicone resin superior to the straight phenolic resins and to the epoxy-modified resins for exposure to high temperatures for fairly long periods of time. The other, Plyophen 23-057, is a polyamid-modified phenolic resin developed especially to withstand ablation and burn-through resistance when the material is exposed for short periods of time to temperatures in excess of 6000°F.

Circle No. 235 on Subscriber Service Card

A-C Coupling Card

Computer Logic Corp. is marketing a plug-in logic coupler card, Model AC-1. The solid-state coupling card is compatible with the 200 kc series of digital logic circuit modules.

Circle No. 236 on Subscriber Service Card

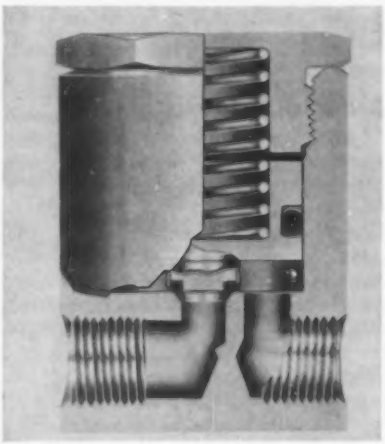
Frequency Meter

A series AFM Automatic Frequency Meter available from Somerset Radiation Lab. Inc. satisfies the general-purpose frequency measuring and monitoring requirements for a simple, fully automatic but economical instrument that can be used in conjunction with commonly-available microwave instruments for continuously monitoring microwave frequencies. The AFM indicator employs a sensitive, aircraft-type, dual-meter movement that permits reading frequency directly and unambiguously at the intersection of one pointer, whose position is a function of frequency and power level, with another pointer, whose position is solely a function of power level.

Circle No. 237 on Subscriber Service Card

Priority Valve

Complete isolation of any portion of hydraulic or pneumatic systems below a preset point is available in a line of priority relief valves from Circle Seal Products Co. The P-458 Priority Relief Valve, operating at pressures to 2000 psi, is externally referenced, with actuation accomplished by absolute system pressure rather than differential pressure



between inlet and outlet. Fail-safe valve closure is effected by positive spring pressure whenever downstream pressure drops below design closing pressure.

Circle No. 238 on Subscriber Service Card

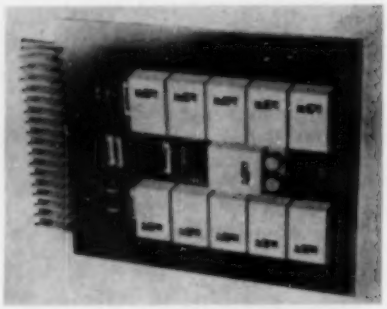
Liquid Lathe

A liquid lathe for cutting materials is available from Abrasi-Jet Machine Tool Corp. The liquid lathe, a machine which resembles a cannon, delivers a needle point of liquid under thousands of pounds of pressure capable of cutting through cement, wood and tough plastic. An immediate practical market for the concept was found in the safe removal of high-energy solid-propellant materials from engine casings. Models for cutting and shaping metals and other materials are under development.

Circle No. 239 on Subscriber Service Card

Magnetic Shift Register

The Magnetics Research Co. has available a multidirectional shift register. Information is taken in and out of the 10-bit register in series or in parallel. The direction of information transfer can be changed in between shift pulses.



Information can be transferred from register to register on command. As a shift-right, shift-left 10-bit unit, it has wide application as a reversible preset decade counter with outputs available for each unit of the count. Input information can be gated into the register under control of the flipflop, and use can be made of this feature to directly encode punch card information into magnetic tape code.

Circle No. 240 on Subscriber Service Card

Adjustable Resistors

Ohmite Mfg. Co. is furnishing the complete range of adjustable resistor sizes and resistances to meet the "C" revision of MIL-R-19365. The adjustable resistors are constructed in the same fashion as Ohmite fixed, power resistors. Resistance wire is wound on a high-quality ceramic core and covered with a high-quality vitreous enamel. On the Dividohm-type resistor, however, a bared strip of resistance wire is left exposed for tapping by means of one or more adjustable lugs.

Circle No. 241 on Subscriber Service Card

Vertical Sensing Element

Kearfott Division has available the C70 1808 000 vertical sensing element, a single-axis, proportional low-cross coupling error, damped, bubble type, electrolytic unit. Its sensitivity is virtually unaffected by sustained cross accelerations up to 1 g, and it can withstand more vibration in the low-frequency high-amplitude range than any other unit of its type currently available.

Circle No. 242 on Subscriber Service Card

Directional Couplers

Waveline, Inc., has designed miniature 6 db waveguide directional couplers with excellent coupling characteristics over a broad band frequency range.

These directional couplers combine small physical size with a minimum of coupling variation over a large portion of the waveguide frequency range.

Special designs may be generated for miniature couplers with coupling values from 5 to 10 db. These special designs will adequately cover a 12% bandwidth of frequency range with a maximum coupling variation of ±0.5 db.

Circle No. 243 on Subscriber Service Card

Portable Ripple Meter

A Model T256 Ripple Meter specifically designed to measure ripple voltage on aircraft and missile d-c power supplies is available from Atron Manufacturing, Inc. The T256 can also be used as a battery or line-powered, transistorized volt-meter. Its sensing method can easily be set to "peak to peak," "plus peaks," "minus peaks" or "RMS,"

so that one instrument can check a variety of specifications and read quantities that can't be easily measured on an oscilloscope. A large meter with color-coded scales simplifies reading.

Circle No. 244 on Subscriber Service Card

Alumina Ceramics

Diamonite Products Mfg. Co. has facilities available for volume production of high-alumina ceramic parts and components for production metalizing. Metalizing may be performed using the moly-manganese, titanium hydride reactive metal or any other suitable processes to which the metal can be brazed. If desired, the metalized section can be plated prior and subsequent to the brazed assembly.

Circle No. 245 on Subscriber Service Card

Silicon DC Power Supplies

A line of silicon d-c power supplies for virtually every industrial application requiring d-c power has been announced by General Electric's Low Voltage Switchgear Department. Available in ratings from 0.75 kw to 75 kw, the line is divided into three basic industrial rectifier groups consisting of general purpose units, essential service units and synchronous motor field excitation units.

Circle No. 246 on Subscriber Service Card

new literature

THERMOSTATS—A four-page bulletin describing a line of commercial types A and AY snap-acting, fixed-temperature thermostats is available from Stevens Mfg. Co. The four-page technical data bulletin describes the various models comprising the line, gives information on available terminals, mountings, etc. Ranges, ratings, differentials also are covered.

Circle No. 200 on Subscriber Service Card

GLASS DATA—Expanded data on corrosion resistance and thermal expansion of 32 commercial glasses are major additions to a revised booklet published by Corning Glass Works. The average expansion coefficient from room temperature to the setting point of the 32 glasses is given for use in sealing applications. A new numerical code system shows the resistance of each glass to weather, water and acid.

Circle No. 201 on Subscriber Service Card

BUSHINGS—Adjustable Bushing Co. has published a 32-page pamphlet quickly describing the product and typical usage of adjustable wall-thickness bushings and associated Adjusto-Fit products. The pamphlet (No. 60A) is illustrated with line drawings showing how cylindrical fits are obtained in bolting structural joints, clevix and hinge pins, rod end bearing pins, bearing and seal applications, etc.

Circle No. 202 on Subscriber Service Card

AUTOMATIC COIL WINDING—An 8-page brochure on the technique of fully automatic coil winding is available from Industrial Winding Machinery Corp. This pamphlet describes the operation of Aumann Model WPA coil-winding machine which can be equipped for semi- or fully automatic winding of field coils, bobbins, voice coils, armatures, etc.

Circle No. 203 on Subscriber Service Card

ELECTRONIC TRAINING—A 32-page brochure titled "How to Train Electronics Personnel" has just been published by the Cleveland Institute of Electronics. Created to outline the potentials offered through home study of the Electronics field, the booklet's contents are directed to industrial employers, utilities, government officials, commanders of military units and educators. The brochure discusses the growing requirements for trained people in this fast-growing field and the upgrading of those already in it, as well as the techniques used by the Cleveland Institute and the home study educational group generally in fulfilling these needs. The booklet also contains a comprehensive catalog section describing in detail the technical courses offered by the institute.

Circle No. 204 on Subscriber Service Card

names in the news

FELDMANN

GUARINO

VOLKERS

BAILEY

GOSS

Robert E. Lewis: Former president of Sylvania Electric Products, Inc., joins Perkin-Elmer Corp., Norwalk, Conn., as president and chief executive officer.

John R. Harkness: Appointed vice president-marketing for Librascope Division, General Precision, Inc., Glendale, Calif. Harkness formerly was manager-electronics for Bendix-Pacific Division.

Henry Feldmann: President of FXR, Inc., Woodside, N.Y., elected to the board of directors of Amphenol-Borg Electronics Corp. following the merger of FXR and Amphenol-Borg. FXR becomes an Amphenol-Borg Division with Feldmann continuing as its operating head.

L. Berkley Davis: Vice president of General Electric Co. and general manager of GE's Electronic Components Division, Owensboro, Ky., re-elected president of the Electronic Industries Association.

Leon F. Goode, Jr.: Thirty-three-year-old scientist, named manager of the *Nike-Zeus* missile system with Surface-to-Air Projects Office at White Sands Missile Range, N.M. Formerly Goode was associate development engineer with Oak Ridge National Laboratory.

Edward F. Canfield: Appointed assistant to the vice president of marketing of Philco Corp.'s Government and Industrial Group, Philadelphia.

Henry E. Schauwecker: Appointed vice president and director of engineering of U.S. Science Corp., Los Angeles. Schauwecker formerly was chief electronics engineer for the Technical Products Div., Waste King Corp., and president of Valor Instruments, Inc., Gardena, Calif.

Nicholas J. Guarino: Joins Space Instrumentation Div., Technology Instrument Corp. of Acton Mass., as aeromechanical engineer. Previously served at the AF Cambridge Research Laboratory and as project engineer at Wright Field Propulsion Laboratory.

Dr. Lewellyn T. Boatwright, Jr.: Appointed director of engineering for Sparton Southwest, Inc., Albuquerque, N.M. Prior to joining Sparton, Dr. Boatwright was chief of the radiac instrumentation section in the Research Directorate at the AF Special Weapons Center.

Dr. Walter K. Volkers: Elected president, director and chief executive of Lionel Corp.'s Electronic Laboratories, formerly Anton Electronic Laboratories, Brooklyn, N.Y. Prior to joining Lionel, Dr. Volkers was vice president of research and development for the Massa Division of Cohu Electronics, Inc.

George F. Anisman: Appointed western region manager of Telecomputing Corp., Los Angeles. Formerly, Anisman was director of marketing for the Whittaker Controls Division.

R. J. Bailey: Appointed vice president of English Electric Corp., and continues as manager of the Marconi Instruments Division, Englewood, N.J.

Bernard M. Brenner: Named manager of the Advanced Development Dept. of Ampex Instrumentation Products Co., Redwood City, Calif.

Howard M. Wittner: Named manager of marketing at General Electric's Missile and Space Vehicle Dept., Philadelphia. Wittner, formerly manager of unmanned spacecraft projects, MSVD, replaced **D. T. Atkinson,** recently named executive vice president of Communication Satellites, Inc.

Dr. Lothar W. Nordheim: Chairman of the Theoretical Physics Dept. and a senior research advisor at General Dynamic's General Atomic Division, elected to a three-year term on the board of directors of the American Nuclear Society.

A. L. Hammerschmidt: Appointed chief engineer, RCA's Missile and Surface Radar Division, Moorestown, N.J. Prior to joining RCA, Hammerschmidt was vice president of the Engineering and Facilities Administration of the National Broadcasting Co.

Claude T. Brown and **William B. D. Harris:** Appointed to the engineering staff, Tele-Dynamics Division, American Bosch Arma Corp., Philadelphia, specializing in underwater telemetry development work.

Col. Samuel W. Bishop, USAF (ret.): Elected president of Electronic Communications, Inc., St. Petersburg, Fla., succeeding **F. W. Godsey, Jr.,** who becomes vice chairman of the board of directors. Col. Bishop was associated with engineering procurement and production aspects of AF missiles and aircraft from 1944 until his retirement this year as Deputy Chief of Staff for Materiel of the Air Research and Development Command.

Joseph A. Waldschmitt: Elected president and chief executive officer of Page Communications Engineers, Inc., Washington, D.C., a subsidiary of Northrop Corp. Waldschmitt succeeds **Esterly C. Page,** elected chairman of the Page board.

Dr. Wilbur H. Goss: Presented the Navy Distinguished Public Service Award for his individual contributions and leadership in guided missile research and development. Dr. Goss, leading scientist in the *Talos* missile program and co-inventor of the supersonic ramjet engine, is assistant director for technical evaluation at the Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.

Robert F. Tangren: Former associate manager of research at the Solid Rocket Plant, appointed manager of the newly-created Space Propulsion Division, Aerojet-General Corp., Sacramento, Calif.

Col. Bernard W. Marschner: Vice president of the Holloman Section, American Rocket Society, appointed Professor of Aeronautical Engineering at the Air Force Academy. Col. Marschner's past experience at Holloman includes director of Ballistic Missile Test; deputy director, Directorate of Advanced Technology; and deputy for the Guidance Test Facility.

Thomas H. Armstrong and **William R. Lonergan:** Appointed manager of government relations, and manager of product planning and applied programing, respectively, for the Univac Division of Sperry Rand Corp., New York City. **Richard P. Castanias** appointed national sales manager for Univac scientific computing systems.

ENGINEERS • PHYSICISTS • MATHEMATICIANS • LIFE SCIENTISTS—BS, MS, PhD

New Staff Appointments

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STRUCTURAL CONFIGURATION RESEARCH: design problems of very large and/or lightly loaded structures; also heavily loaded vehicles.

STRUCTURAL DYNAMICS: preliminary design calculations of loads, stresses, deflections of structural components (aircraft, missiles, boosters, space vehicles).

THEORETICAL AERODYNAMICS & AEROPHYSICS: original work supporting design and laboratory project experiments re: hypersonic re-entry vehicles; supersonic craft.

AERODYNAMIC PROJECT DIRECTION: studies & appraisals of preliminary aerodynamic designs for diverse flight regimes, including drag analysis, configuration optimization, performance & trajectory analysis.

AERODYNAMIC ANALYSIS & SYNTHESIS: for both powered & ballistic trajectories.

MATERIALS DEVELOPMENT: refractory coatings on refractory metals, & refractory compounds, cermets, intermetallic compounds. Initiation of investigations to meet new requirements.

EXPERIMENTAL CRYOGENICS: establishment & supervision of cryogenics laboratory responsible for varied investigations including developing environmental control systems for spacecraft.

GUIDANCE & CONTROL SYSTEMS: novel components & system development; thin film devices; circuitry; optical & IR systems & tracking devices.

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BIOCHEMICAL DETERMINATIONS on men and plant systems.

MICROWAVE ANTENNA RESEARCH

OPERATIONS ANALYSIS

For detailed information about assignments in the above and other areas please write in confidence to: Mr. George R. Hickman, Technical Employment Manager, Dept. 4F-2

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—contracts—

NASA

$93,000—Space Electronics Corp., Glendale, Calif., for development of a pulse code modulation (PCM) telemetry system for satellites.

NAVY

$1,200,000—Lear, Inc., Grand Rapids, Mich., for ground support equipment and spare parts for the master attitude reference system (MARS).

$127,000—General Atronics Corp., Bala-Cynwyd, Pa., for theoretical and experimental studies in conjunction with the exploratory underwater defense system ARTEMIS.

ARMY

$35,645,500—Fluor Corp., Los Angeles, for *Titan II*, Phase II construction at Davis Monthan AFB, Tucson, Ariz.

$2,025,700—Raytheon Co., Waltham, Mass., for 20 aluminators for the *Hawk* missile system radar.

$1,790,014—Bendix Corp., Systems Div., Ann Arbor, Mich., for a high-altitude downrange airborne measurement program.

$1,471,102—Grand Machinery Co., Detroit, for rocket motor bodies and fins for M150 assembly.

$1,212,881—Sylvania Electric Products, Waltham, Mass., add-on for engineering changes to the *Advent* communications satellite antenna system.

AIR FORCE

$1,131,642—General Precision, Inc., Pleasantville, N.Y., for AN/APN-108 Doppler radar subsystem of the AN/ASQ-48 bombing navigation system.

$40,748—Kin Tel Div., Cohu Electronics, Inc., for ground support equipment instrumentation.

North American Aviation's Space and Information Systems Div., Downey, Calif., from Electronic Systems Div. of AFSC, for 13-month study contract to improve optical satellite observation and prediction techniques. No amount disclosed.

Beech Aircraft Corp.'s Boulder Div., from **General Dynamics/Astronautics,** for tooling, manufacturing and testing of "topping control units" for the *Atlas* ICBM. No amount disclosed.

REQUESTS

The NASA Procurement Office, Marshall Space Flight Center, Huntsville, Ala., will issue a request for proposal ENG 140-61 for design, fabrication, installation and checkout of a complete, approximately 200-ton capacity air conditioning system for installation at Cape Canaveral, Fla.

Proposals are due to be received on or before June 20, 1961, at the Procurement and Contracts Office, Marshall Space Flight Center, NASA, Huntsville, Ala.

The following firms have been invited to participate: American Electronics, Inc., Ground Support Div., 2112 N. Chico Ave., El Monte, Calif.; Carrier Corp., 2015 Peachtree Rd., N.W., Atlanta 9, Ga.; Chrysler Corp., Airtemp Div., 1600 Webster St., Dayton 4, Ohio; Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.; Hamilton Standard, Div. of United Aircraft Corp., Windsor Locks, Conn.; Telecomputing Corp., Advanced Structures Div., 801 Royal Oaks Dr., Monrovia, Calif.; C. G. Hokanson & Co., Inc., 2140 Pontius Ave., Los Angeles 25, Calif.; Trane Co., 871 McCallie Ave., Chattanooga, Tenn.; Worthington Corp., Ampere Station, East Orange, N.J.; York Corp., 525 Plaster Ave., N.E., Atlanta 24, Ga.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

Help Wanted

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Metallurgical Manager—B.S.—M.S., with demonstrated administrative and technical ability. Position involves managing and directing the activities of a modern metallurgical and welding laboratory engaged in both the ferrous and nonferrous fields. This laboratory performs an important function in the operation of a large, integrated facility engaged in both product development and production activities.

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Polaris Guidance

(Continued from page 31)

missile due to ship's motion and subtracts these from the platform accelerometer signals, so that they may be used to erect the platform to local vertical very accurately.

(5) Computes target azimuth and aligns the inner gimbal of the platform to this heading with the aid of SINS as a true north reference, and an optical-electrical servo. At the missile, the misalignment between the SINS and the missile stable platform is measured optically and electrically. This misalignment error, combined with the computed target bearing, gives the final bearing alignment to the missile platform azimuth gimbal.

(6) Continually checks out the guidance system and other missile equipment and displays the missile's state of readiness.

• **Flight mode**—During powered flight, missile pitch-attitude is controlled through the first phase by a programed autopilot, during second phase by inertial-guidance and autopilot subsystems.

Among the major factors contributing to the accuracy or inaccuracy of the guidance system are the computations performed by F/C and missile computer, the SINS inputs, alignments, erection, gyro drift, and accelerometer scale-factor variations. Attainment of accuracy in the missile-borne components is in general more difficult because of strict limitations on size and weight—and the severe penalty of lost range when these are exceeded.

Impact data from test firings of the *Polaris* missile are, of course, classified. However, it can be related that the expression "right in the pickle barrel" has been used to describe the results of several tests. The high proportion of successful tests shots is a record already well documented.

• **Second-generation systems**—Currently, MIT engineers and scientists are designing a second-generation guidance subsystem with industrial support by GE's Ordnance Department (platform) and Raytheon Corporation (computer). Significant improvements in size, weight and accuracy are anticipated, with subsequent improvement in missile range.

A second-generation Fire Control is being designed by GE. The new system, designated the MK 84, will provide greater versatility and operational flexibility for the FBM system. It makes extensive use of new digital computing concept in packaging will make the techniques and will be more automatic than its predecessor, the MK 80. A new concept in packaging will make the MK 84 easier to operate and maintain. ⌘

—when and where—

Instrument Society of America, 3rd International Symposium on Gas Chromatography, Michigan State University, East Lansing, June 13-16.

Joint ARS-IAS Meeting, Ambassador Hotel, Los Angeles, June 13-16.

Applied Mechanics Conference, American Society of Mechanical Engineers, Illinois Institute of Technology, Chicago, June 14-16.

American Society for Testing Materials, Annual Meeting, San Francisco, June 16-21.

IAS Symposium on Space Flight and Reentry Trajectories, Paris, June 19-21.

Heat Transfer and Fluid Mechanics Institute, University of Southern California, Los Angeles, June 19-21.

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editorial . . .

Put the People 'in the Picture'

PRESIDENT KENNEDY'S recognition in his special message to Congress that we are indeed in a race with the Russians to put a man on the moon is gratifying.

To his declaration that it is time for this nation to take a clearly leading role in space achievement, we might add that it is well past time. But we would feel somewhat better about the whole program if the President had been less nebulous about the purpose of the exercise. He was frank in pointing out that our drive into space may cost up to $9 billion over the next five years. He was less than clear in explaining why such an expenditure is necessary.

"We go into space because whatever mankind must undertake, free men must fully share," the President told Congress. A noble sentiment; but the message might have been more effective if he had spelled out more specifically in terms of national prestige and military security just why it is necessary to expend the money and effort on such a mammoth undertaking.

There is no need for us to emphasize the reasons here. We have outlined them before. But members of the lay public, taxpayers who are being asked to foot the bill for this program, deserve answers to such questions as why we are not spending this money on projects closer to home—"something like cancer research."

This reflects one of the most irritating and fallacious arguments against space expenditure yet devised, based on the false assumption that if we don't spend money on a lunar expedition, we will perhaps spend it on cancer research. We will not. Cancer has been with us a long time and we have yet to spend that kind of money trying to find a cure for it, although we have been financially capable of doing so.

This should be explained to the taxpayer. So should the positive reasons why we are going into space. Yet the President gave no indication in his message of any reason beyond a desire to "win the battle for men's minds" by putting an American on the moon before a Russian gets there.

The Administration is doing itself and the nation a disservice by refusing to acknowledge the valid military reasons why we must not let the Russians dominate space.

It is apparent from reading between the lines of the message and from a study of the funding outlined that the military mission is not to be neglected. It would be more forthright to acknowledge this as one of the purposes of our stepped-up space program—and to implement it with direct financing.

Such a course of action, we feel, would lend a greater sense of urgency to the program.

WE WOULD be less than just, however, if we failed to acknowledge a differing point of view. It is ably expressed by a man who has a much more intimate knowledge of crash programs than we do. Dr. Simon Ramo, executive vice president, Thompson Ramo Wooldridge, Inc., had this to say on the subject to the Fifth Symposium on Ballistic Missile and Space Technology:

"It would be wrong . . . to imagine that the quickest and surest way to create a successful crash program is to be certain that the public as a whole accepts the need. This reasoning starts from the idea that only by wide public appreciation will the funding, the priorities, and the broad backing needed for a large program be achieved. There is truth to this, but it is a remarkably self-complicating phenomenon. If a program is sufficiently well known, then there will inevitably be too many in the act—some anxious to help, others merely anxious to participate, all anxious to have a say—and our national habit is to feel compelled to honor all of this interest. We fall into a pattern of broad participation by everyone in most aspects from basic decisions on the planning of the program to its implementation and its detailed execution. What results may be called a crash program, but it can be so in name only. It may be large and well known, but it will not move along nearly so fast as it might otherwise have been able to."

The pitfalls outlined by Dr. Ramo certainly must be avoided in our lunar effort. But we still feel further public definition of why we are sending men into space is required if the program is not to bog down in a confusion of objectives.

William J. Coughlin

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